PUBLIC WORKS

Devoted to the interests of the engineers and technical officials of the cities, counties and states

MARCH, 1940

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TIMEWASTERS

The plight of the bandit's children, reported in the February issue, appears to have evoked some sympathy—principally for the sister who fared distinctly poorly—and a great deal of perplexity. There appears to be at least two solutions, maybe more. The most complete solution is from James A. Vinson, of Kentucky. Mr. Bevan sent a rather incomplete solution. Here is what Mr. Vinson has worked out, in summarized form: There was $80 in bills; one brother got $42; the other $38. There were 49 bars of bullion, of which 23 were of gold and 26 of silver, and the aggregate weight of the bullion was 1521 pounds. The weight of each bar of gold is 39 pounds (Mr. Bevan reports 39.39) and of each bar of silver 24 pounds (Mr. Bevan says 24.24 pounds). Each of the brother's mules carry 213 pounds, and the sister's mule totes 243 pounds. The boys get 9 bars of gold each and 12 bars of silver; the gal gets 5 bars of gold.

Walter Wheeler, in N. H., checks Mr. Vinson pretty well as to the money and the weight of the bullion, but—well, see page 49.

Fishy!

A whale, says Mr. Wheeler, is seven times as long as a shark; the sum of their lengths equals four times what the length of the shark would be if the shark were twice as long as it is, but seven times what the length of the shark would be if the shark were one foot longer than it is. Wanted: The length of the fish.

And Worse:

$A+B+C+D=A\times B\times C\times D$, says the CES Math Trust, the letters representing whole numbers.—W.A.H.

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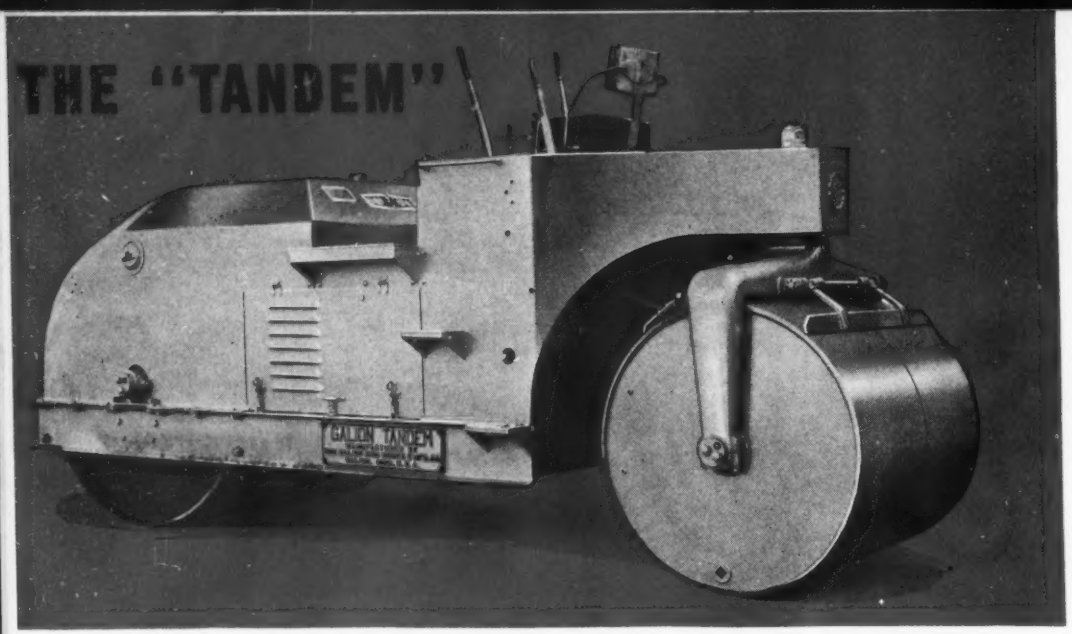

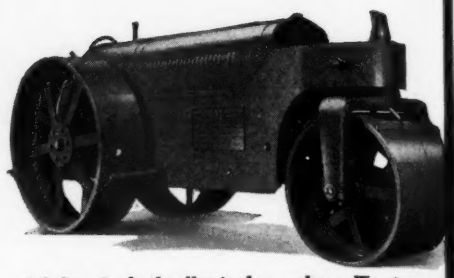

A Galion 3-wheel roller is shown above. Warrior or Cl styles in 6 to 12-ton sizes with either gasoline or di engine. A Galion tandem roller is shown at the left. sizes with variable weight range of 5 to 14 tons.

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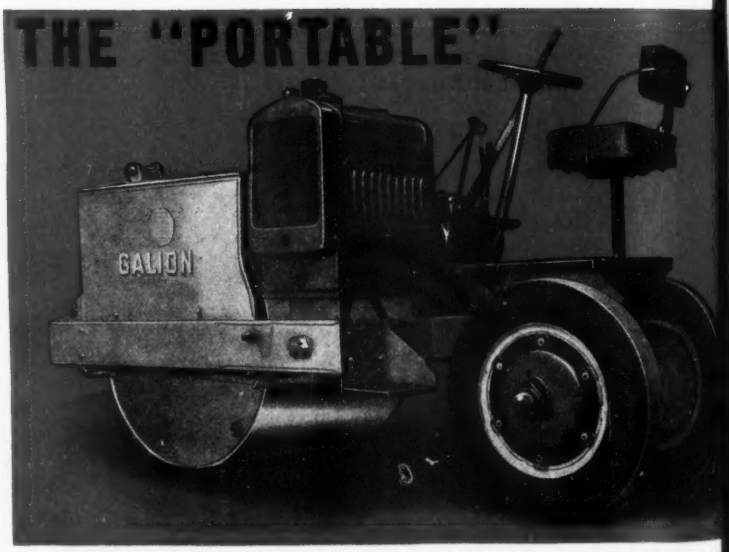

A lightweight general service roller is the portable shown above. Weight is varia from 7500 to 10,000 lbs. Shown left below is the sheepsfoot roller used for tampi earth fills. Can be furnished in any number of combinations.

THE GALION IRON WORKS & MANUFACTURING COMPANY

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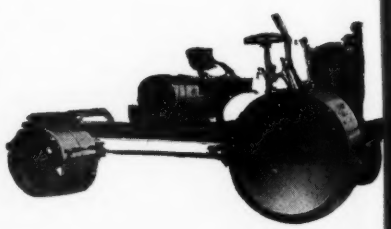
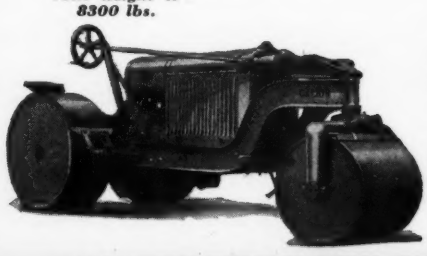
Galion trench roller (right) for special work such as road widening, relocation, elevating curves, etc. Either 10 or 20" rolls. 25.5 H.P. 4-cylinder gasoline engine. With 20" rolls weight is 8300 lbs.





Galion International 3- wheel roller with var able weight from 4 t 5 tons for patching repair, shoulder mai tenance, resurfacing light construction an rebuilding jobs. Inter national 1-30, 4-cylin der power unit.

PUBLIC WORKS Magazine • • MARCH, 1940

VOL. 71. No. 3

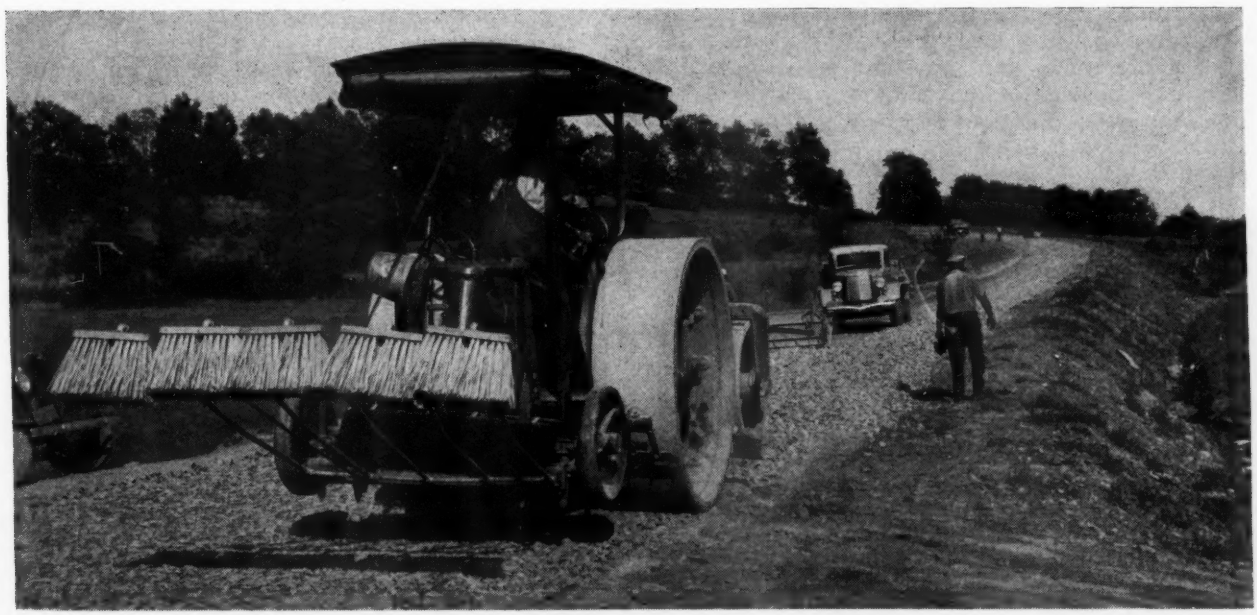
Mr. Scanlon

Combining Relief Labor and Modern Machinery to Construct High Type Roads

By BART J. SCANLON

UNDER the supervision of E. B. Pendleton County Highway Superintendent, Chenango County, N. Y., has made an exceptionally fine record in the construction of roads built to endure. By consistently following the policy over a period of years of building such roads, Chenango County now has 255 miles of improved county highways. These are not merely hard surface farm-to-market roads, but are modern highways built with at least five hundred feet of clear vision and in very few cases does the grade exceed five per cent.

Previous to 1935, new construction in Chenango County was carried on by the county highway forces. In July 1935, the county was visited by the most destructive flood in its history. As a result, miles of Chenango County highways were so badly damaged as to need major repairs. In order to repair the flood damaged roads as quickly as possible, Mr. Pendleton appealed to the newly formed WPA for assistance. Several large flood repair projects were set up, and in order to speed the work, county highway forces were combined with WPA workers.



Rolling sub-base in place. Note brooms on roller

Belt conveyor loading crusher dust

Washed out sections of county roads were replaced, concrete bridges constructed to replace those washed out by the flood waters, and shoulders and sluices repaired. As a result, in spite of the heavy damage suffered during the flood in Chenango County, the highways were restored to use in a remarkably short period of time. This plan of cooperative action, developed during the flood emergency, was continued after the flood repair program was completed as a large scale county highway construction program.

During the past two years, seven County-WPA projects have been completed at a cost of $621,104.83. The completion of these projects has added 34.72 miles of new macadam road to the Chenango County highway system. Two other projects calling for the construction of 12.83 miles of road at an estimated cost of $438,734.19 are now under construction. These two projects call for the construction of 18-foot macadam pavement with a 10-inch sub-base, a 3-inch intermediate base of crushed stone and a 2½-inch bituminous top. The seven completed projects are 16-foot macadam pavement with a 10-inch sub-base, a 3-inch intermediate base of crushed stone and a 2½-inch bituminous top.

Probably the outstanding feature of the highway construction program has been the fact that it has been planned on the year round basis to give continuous employment to men taken from the home relief rolls. At the same time, the planning has included scheduling the work in such a manner that the labor and equipment have been put to the best possible use during each season of the year. To this end, no attempt has been made to carry on road construction work during the severe winter weather. The county has acquired four quarries and installed crushers. As soon as cold weather makes the operation of the road projects inadvisable, the men and equipment are transferred to the stone quarries. There they crush and stock-pile stone in preparation for the resumption of the road construction program in the spring. The largest crushing plant is capable of producing 250 cubic yards of crushed stone in an 8-hour day. Three smaller plants produce from 80 to 100 cubic yards a day. The crushers produce #1, #2 and #3 stone. The crusher dust is stock piled by the county and used in construction of the intermediate course.

As in the case of the road jobs, WPA pays all the wages of relief laborers employed on the crushing jobs and purchases some of the material. The county acquires the sites, sets up the crushing plant and provides the trucks and other necessary equipment.

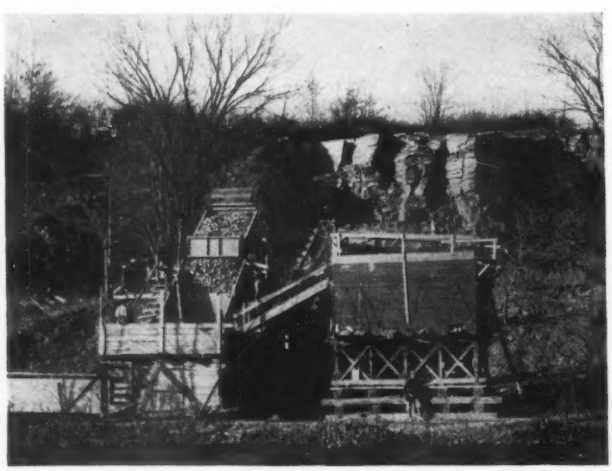
The operation of the stone crushing projects has given employment to an average of 200 men during the past two winters. The WPA workers split shifts, that is to say, only half the number assigned to the project are on the job site at any one time. This keeps the machinery and the stone crusher plants in continuous operation.

For the past several seasons, it has been the usual practice to start the grading of roads, which are to be improved, in the spring. The grading operations, installation of drainage structures and construction of bridges are carried on through the summer and fall. The sub-base is laid before cold weather sets in. Work is then suspended until spring and the base is allowed to settle during the winter. The next spring, the soft spots and pot holes, developed during winter, are carefully filled and the entire sub-base rolled smooth before the work is started on the intermediate course.

In this whole program the county furnishes necessary skilled labor not available from relief rolls. The work is superintended by special foremen. For instance, as in the case of bridge construction, the regular Chenango County Bridge Foreman superintends the job in cooperation with the WPA superintendent.

An important factor is that Chenango County has provided modern up-to-date equipment. Hand labor is used only where its use is most effective.

Probably, the controlling reason in the construction of better-than-average county roads in Chenango



Typical quarry setup and crusher

Spreading sub-base material; note heavy fill

Adams grader and Lorain ¾-yd. shovel on grading operations

County is the fact that it is one of the largest milk producing counties in the New York milk shed. Heavy tank trucks, carrying the county's principal product to market, require something better than a light gravel road typical of most farm-to-market construction. For this reason, Mr. Pendleton contends, the county will save money in the long run because maintenance costs on the heavy-type roads built under this program will be much lower than on lighter road surfaces.

The cost of the program has been shared between the WPA and the county, with the county paying $452,877.10 or 72.7 per cent and WPA $168,327.64 or 27.3 per cent. For most part, the WPA funds went to pay the wages of relief laborers, with $132,476.84 going for this purpose and $35,850.80 for the purchase of materials for the projects. The county's expenditures were not made wholly in cash but represent also allowances made by WPA for a reasonable rental value of the equipment furnished for the work and for material bought by the county. Practically in all cases, county owned equipment was operated by regular county operators. Between 250 and 300 men have worked on the road construction program.

Methods Used in Construction

The bulk of the construction was done with diesel powered shovels. The grading operation was done with an Adams #51 motor grader. No effort is spared to straighten the road. Roads are relocated where necessary and curves eliminated in order to provide 500 feet of clear vision. Some idea of the amount of excavation necessary is indicated by the fact that on 34.72 miles completed under the program, a total of 586,600 cubic yards of excavation have been made. Of this amount, 554,600 cubic yards were handled by machine and only 32,500 by hand.

Because of the topography of the county, a large number of flash streams cross the county highways. Great care has been taken to provide adequate drainage and to prevent a recurrence of the damage that was caused in the county by the floods of July, 1935, and March, 1936. To this end, a large amount of concrete pipe culvert has been installed on the new roads. Some of it is as large as 36-inch. Where culverts were inadvisable on small streams, bridges have been erected. Six bridges were constructed on the seven projects now completed. Four of these were reinforced concrete, one had a span of 8-ft., one a span of 12-ft., one of 14-ft. and one of 20-ft. Two other bridges were steel I-Beam type with 45-ft. spans. Five reinforced concrete box culverts were installed where concrete pipe culverts would not provide an adequate margin of safety.

After the drainage structures are installed and the bridges are in place, the sub-base is laid in two operations. The first operation consists of rolling in place a 6-inch course of run-of-bank coarse gravel. This is covered with a 4-inch course of finer gravel rolled in place. This final course is primed with oil where necessary.

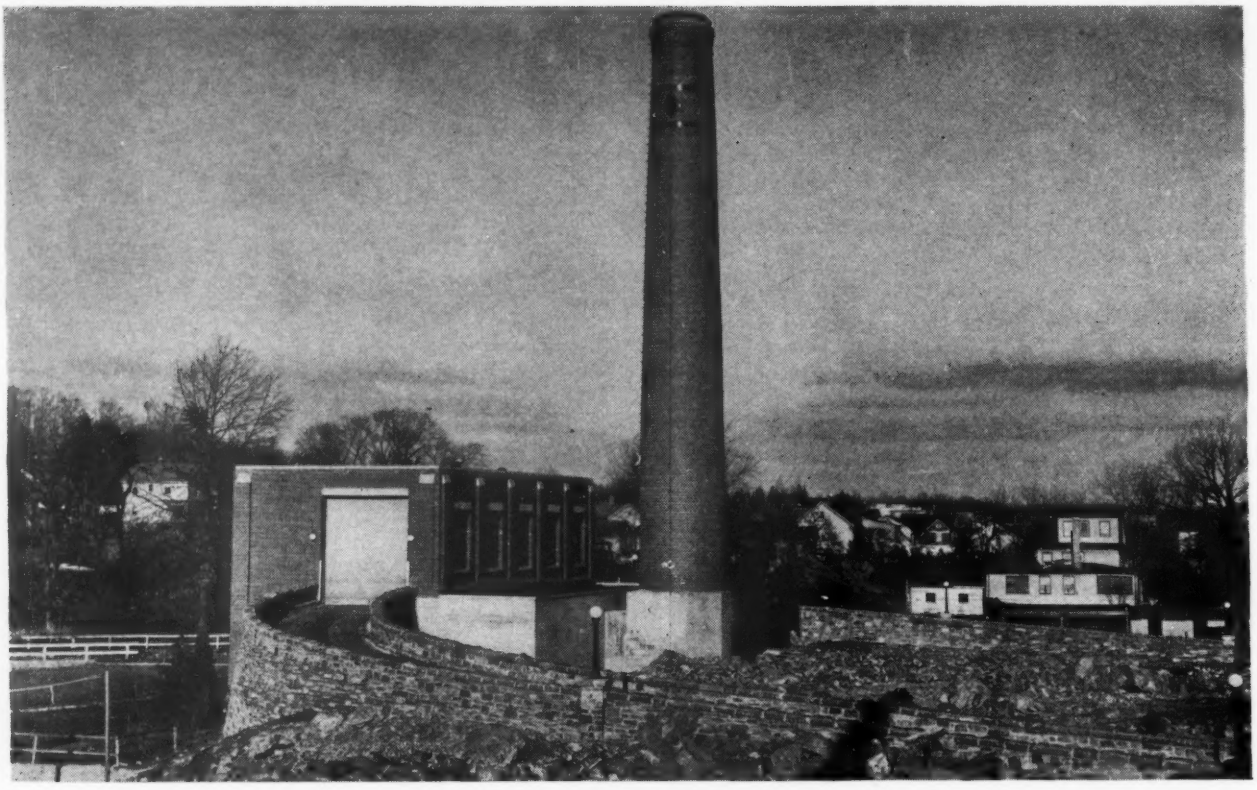
An Adams power grader is used to spread the sub-base and hand labor is used to fill in the low spots. A York stone rake hauled by a power grader is used to smooth out the sub-base. Then the sub-base is rolled smooth. A 10-ton three-wheeled roller, and one 10-ton tandem roller are used in this operation.

The intermediate course of #3 crushed stone is spread with a Burch box type stone spreader. Enough stone is used to allow 25% compression.

After the intermediate course has been rolled in place, it is filled flush with crusher dust and rolled to an even 3-inch thickness. It is broomed by using brooms on rollers. This course is then primed with light oil using 0.4 gallons to the square yard.

The mixed-in-place top course is constructed by using No. 2 crushed stone and cut back asphalt, Item 69 M, as specified by the New York State Highway Department. Sufficient No. 2 crushed stone is spread half-width over a section of the road 1,500 to 1,800 ft. in length by using a spreader box to such a depth that when finally spread, mixed and compacted, it will leave a top course 2½ inches in thickness over the entire width of the pavement.

(Continued on page 38)



View of Mamaroneck Incinerator, showing ramp with stone walls.

Incinerator Replaces Dump and Permits

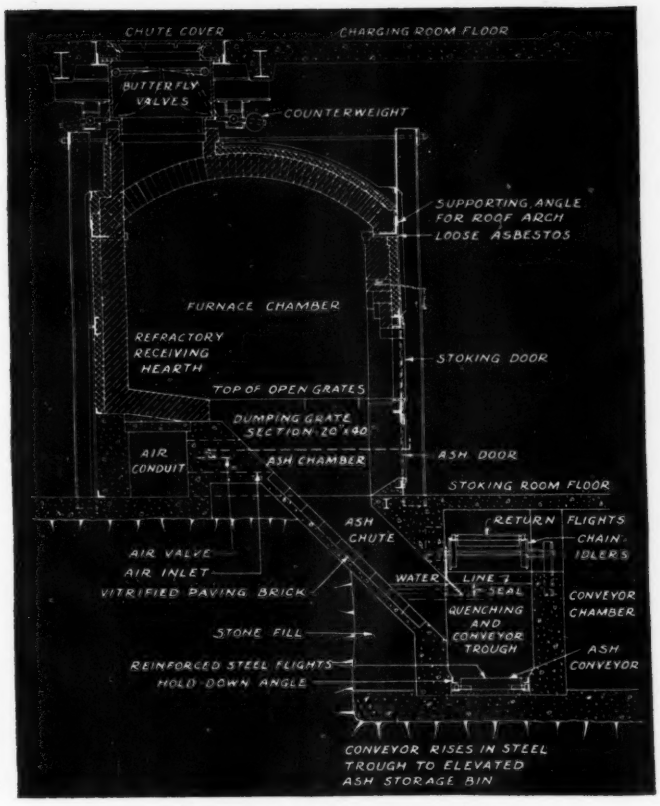
By HENRY W. TAYLOR
Consulting Engineer

FOR years the mixed refuse from the Village of Mamaroneck, N. Y., has been disposed by dumping on land adjacent to the harbor. This area was located south of the Boston Post Road and was completely exposed to the view of traffic on one of the main thoroughfares of the country. During 1937, the need for some suitable method of disposal was keenly appreciated from both the sanitary and scenic angles. The dump also interfered with development of the harbor which included filling in the original dump by dredging from the lobes of the harbor. Incineration was decided upon, and as soon as the incineration project described in this article could be placed in operation, the harbor improvement was initiated and the whole complexion of this area adjacent to the Boston Post Road was rapidly changed from the usual atmosphere of a smoking dump with flying papers, to a beautifully developed harbor with local stone retaining walls and subject to landscaping and to use for park, playground and boating purposes.

The first plans were prepared for an incinerating capacity of 60 tons per 24 hours. These plans and specifications were submitted to the contractors and bids received early in 1938. However, there was an underlying suspicion that the design capacity would not be adequate for the demands of the municipality and that a review of the plans and specifications would be well worthwhile, and the writer was retained to review the proposed layout and make a field investigation of the quantity and type of mixed refuse to be disposed of.

The field investigation disclosed a demand, on two days of the week, of between 35 and 40 tons per day, with an average demand on the remaining four days of the week of approximately 22 tons per day. The collection of mixed refuse in Mamaroneck is accomplished from 1:00 A.M. to about 10:00 A.M. The village is divided into several districts and collection is made from each district every other day. The field investigation indicated heavy peak loads on Mondays and Tuesdays and also established the average demand for the latter four days of the week. Field analyses were made of representative samples after field sorting, and as a result of these physical and chemical analyses, various recommendations were made relating to modifications in the methods of collection to divert institutional coal ashes to the dump. The investigation also brought to light several commercial and industrial problems which needed regulation by village ordinance and modifications in the collection system as well.

The net result of the review was the recommendation that the plans already prepared be revised as to capacity, type of plant, and methods of handling material. New plans and specifications were prepared and contracts were let in September, 1938. The new plans



Cross-section of furnace chamber

With a gross cost of construction, of less than $700 per ton, a modern incinerator was built, eliminating an unsightly dump and permitting the development of a boating harbor, park and playground. Cans in garbage presented a problem.

Development of Boat Harbor and Playground

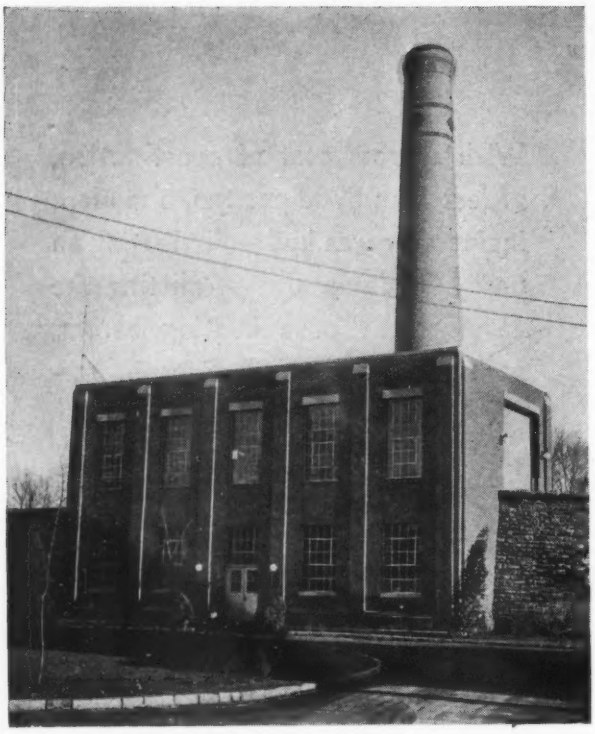
called for two units with a combined capacity of 108 tons per 24 hours, with the idea that this capacity would be adequate for peak loads on the first two days of the week and that one unit would be capable of handling the average demand for the remaining four days of the week.

The plant was arranged as a drive-through plant with in and out ramps. The stoking floor was located at grade level for the front of the building and is adequately flooded with light. Each unit is provided with an open burning grate designed on the basis of one square foot per ton per day of rated capacity with an addition of 50% of this area for a refractory receiving and drying hearth back of the grates. The charging chutes were equipped with heavy counter-balanced butterfly valves, balanced to resist a weight of about 30 lbs., which gates close quickly after the charge has left the valves, cutting off the inrush of cold air to the furnaces below. Each furnace contains two separate cells separately supplied with air and each cell is equipped with a geared dumping grate. Each unit consists of an adequate furnace chamber, a baffled combustion chamber with a capacity of 15 cu. ft. per ton of rated capacity, and a combined and limited expansion chamber serving both units. The chimney is 5' 6" in diameter, lined throughout, and extends 95 ft. above the level of the grates. The diamond shaped ornamentation, near the top of the chimney, consists of tuyere holes between black enamel brick. Air can be drawn through these tuyere holes, down along the outer face of the firebrick lining and to the fans, producing a low degree of preheat, the limit being about 200 degrees F. Each unit is equipped with a forced draft fan with capacity of 6,000 c.f.m. at 70 degrees F.

The dumping grates discharge the furnace residue into a masonry ash hopper underneath each cell with a masonry chute extending to a concrete trough filled with water which serves as a quenching trough and a water seal for the ash pits. A steel hood at the end of this masonry ash chute provides the water seal. The trough containing the water is equipped with an endless-chain, reinforced steel-sweep conveyor, which delivers the quenched ashes to an elevated ash storage bin. Ash removal is accomplished by trucks backing under this ash bin at grate level.

Building heating and hot water supply was provided for by hot water coils with forced circulation installed in the combustion chambers of each unit. A 2,000 gallon hot water storage tank conserves accumulated heat for use when the incinerator units are not in operation.

Unfortunately, although the review dictated doubling the capacity of the project, the appropriation for the project had already been made and was not subject to



Another view of the attractive plant.

a similar increase. After the purchase of land and other overhead expenses, there remained for construction under the new plans and specifications a total of only $67,000. The re-design was based on an attempt to limit the cost insofar as possible to these very restricted financial limitations. Consequently such accessories as pre-heaters, charging containers and gates, equipment to apply auxiliary fuel, instruments and many other accessories were out of the question, and the architectural treatment of the building was necessarily influenced by strictest economy. Most of the outside work was done under the auspices of the W.P.A., including the local stone retaining walls, the ramps, roads and rough and finished grading of the site. As a result of these various economic measures, the gross cost of the construction of the plant was less than $700 per ton.

This project involved a study of the relative merits of a back-in truck ash tunnel and an ash conveyor with elevated ash bin. The truck tunnel would have been subject to backflooding by the Mamaroneck river unless it were ramped to the elevation of the stoking room floor, and consequently the estimated cost of the truck tunnel construction outside the building aggregated almost as much work as the tunnel section underneath the plant building. The plans were prepared so as to obtain alternate bids on an ash conveyor with ash storage bin and a very restricted back-in truck tunnel. The bids received indicated that the ash conveyor scheme could be installed at the smaller cost and it was therefor adopted. However, financial limitations did not permit the use of cast-iron bottom plates for the conveyor, and the sweeps run over a concrete floor for the flat portion of the conveyor and over steel plate for the inclined section of the conveyor. This installation indicated the exacting necessity of small clearances between the bottom of the sweep and the floor of the conveyor trough. The concrete floor as first installed had to be removed and re-run to correct original inaccuracy and to allow for shrinkage in the finished concrete of the conveyor trough floor, so as to maintain a clearance of approximately ¼" between the bottom of the conveyor sweep and the floor.

Floating Tin Cans Cause Trouble

There also developed a can problem which never before has been encountered to a serious degree in other installations. The trouble arose from an abnormal percentage of food cans and was further complicated by the delivery to the plant of large industrial cans from a food manufacturing plant. The larger part of all of these cans were merely punctured rather than opened, so that the tendency for some cans to float was aggravated. This flotation in the ash chute proper even led to bridging and jamming, which interfered with the flow of the residue from the ash bin to the quenching and conveyor trough. Minor modifications in the chute itself did not solve the problem, but after experimentation it was found that two high-pressure jets about ⅝" in diameter, with 80 lbs. pressure and used intermittently, instantaneously broke up any jamming that occurred. This simple jetting equipment was installed along each of the four water-seal hoods at the end of the ash pit chutes. Flotation of cans in the conveyor trough, of course, still persists, and a water jet playing on the water surface of the trough forces these cans forward until they are caught by a sweep as it arises from the water surface.

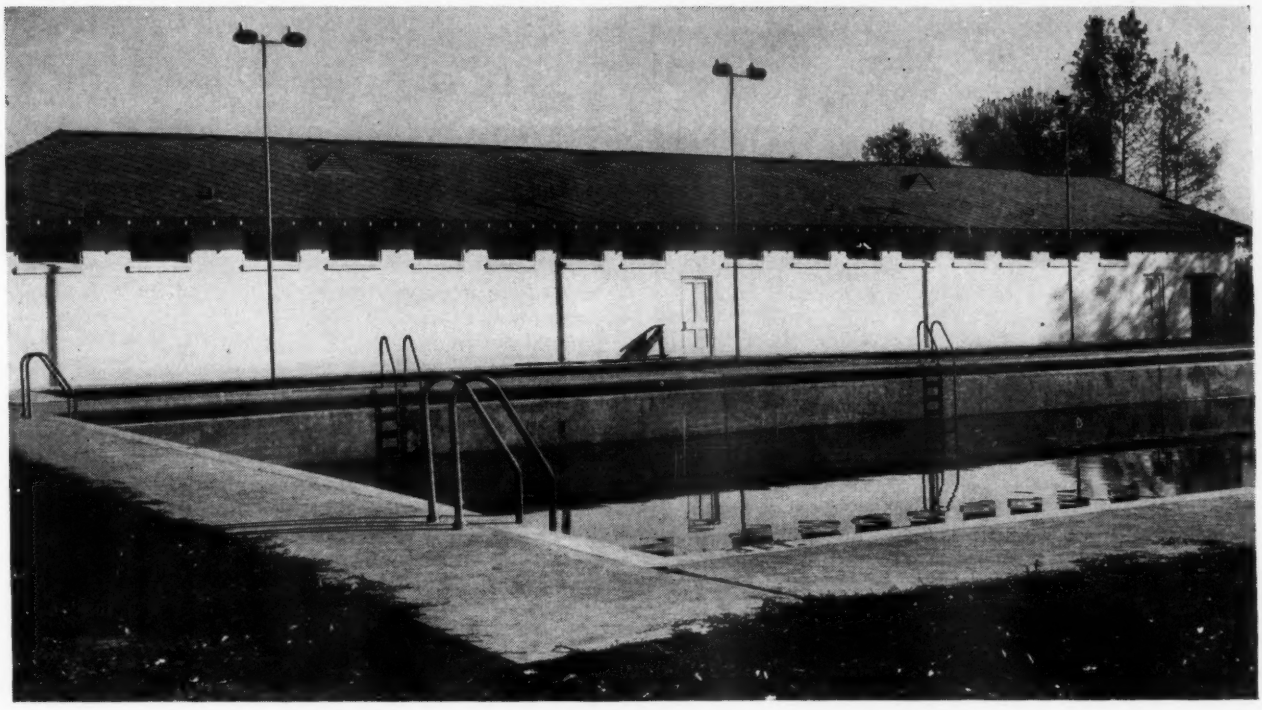
Furnace chambers were built with segmental arches, these arches being supported on skew-backs resting on angles connected to the buckstays, so that all arches were self-supporting. In fact, these segmental arches were built first and the walls below the skew-backs built afterwards. An expansion area underneath the angle supporting the skew-backs was suitably packed and the wall corbelled out to seal the joint. An electric signal system serves for communication between the stoker and the man on the charging room floor and indicates the number of the cell for which a new charge is desired.

A curtain wall extending from the building about 25 feet shields the ash storage bin from public view and also provides a housing for this ash bin, since it lies between the curtain wall and the wall of the ramp, and the area over the bin is practically closed with a concrete slab.

The tests of the plant proved that adequate temperatures could be maintained in spite of the fact that the recommendations relating to the collection system had not been adopted at the time of initial operation. This delay in correcting certain factors in the collection system also interfered with the ease of initial operation for the first few months. However, at present the main problem of operation is confined to the reduction of high temperatures and the attempt is being made to hold these temperatures to an average of from 1400 to 1800 degrees.

The operating capacity of the plant is about 20% in excess of the rated capacity thereof. After the training of green stokers and chargers, and corrective construction by the original contractors which extended over a period of several months, the operation of the plant has been conducted without difficulty with high temperatures, without nuisance and without fly ash complaint.

The plant was designed and consulting supervision of construction was supplied by the author. The work was conducted under the supervision of Village Managers Latimer and Whitney. The general contract was let to A. Barbaresi & Son, and the main sub-contractor was Frank Armour & Co. Plumbing and heating and electric contracts were let to local companies.



Swimming Pool 60 x 120 accommodates 500; locker room in background.

Filtration and Softening Plant and Swimming Pool Built for Opelousas by the WPA

IN cooperation with the Works Projects Administration, the city of Opelousas, La., has constructed a new water filtration and softening plant at a total cost of $70,000, and is now building a new swimming pool, which will be opened to the public this coming summer.

The water treatment plant, which is designed to provide a daily supply of 1,500,000 gallons for the 7,000 residents of the city is expected to be ample to meet all the needs of the city for 10 years or more. The total cost of the plant was $70,000. It consists of a filter and operating house, aerators, mixing basins, coagulation and settling basins, and the filters. The building is of monolithic concrete construction and of excellent architectural design.

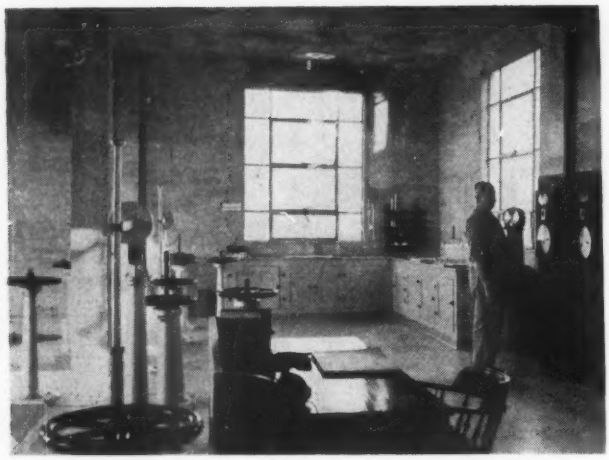
Settling basins with filter house in rear.

The water for the city is supplied by three deep wells, all within 100 feet of the filtration and softening plant. The water is excellent, but high in alkalinity; previous to treatment, alkalinity averaged 297 parts per million. The new plant reduces this to 120 parts per million.

The flow from the wells is controlled by means of valves, so that the required amount only is brought to the filter. The first step in treatment is the passage through aerators. These are in three units, each consisting of a distribution pan and two coke beds about 10 feet deep. Design is based on a rate of flow of 30 gallons per minute per square foot of tray area. The aerators remove about 50% of the free carbon dioxide in the raw water, and also reduce the odor materially.

From the aerators, the water flows to the mixing basin, which is of the paddle wheel type, 12 feet wide and 28 feet long, with a capacity of 32,600 gallons, providing a retention period of 31 minutes at design flow of 1.5 mgd. In the mixing basin, lime is added for softening and sulphate of iron for coagulation. The plant uses about 1,850 pounds of lime and 110 pounds of iron sulphate per day.

From the mixing chamber, the water passes to two coagulation and settling basins, each 22 feet by 75



Filter operating room and laboratory.

feet, and with a combined capacity of 310,000 gallons per day, providing a retention period of about five hours at design flow. The connection between the mixing and settling basins is through a concrete channel which is provided with regulating gates so that either or both of the settling basins may be used, thus permitting cleaning or repairs. Velocity through the settling basins is 0.25 ft. per minute.

Mechanical removal of the sludge is not provided for, and the basin will be cleaned about every 60 days by drawing off the supernatant and removing the accumulated sludge. It is contemplated that the sludge will eventually be used for fertilizer on some types of soil in the vicinity, and temporary storage space has been provided for it in the meantime.

There are three rapid sand filter units, each 13 ft. by 14 ft. in size, with an area of about 175 sq. ft. At the standard rate of 2 gallons per square foot per minute, each of these will have a daily capacity of 500,000 gallons. Each unit is equipped with a rate of flow controller and with operation recording gauges. Beneath the filter units is a clear well having a capacity of 85,000 gallons.

The New Swimming Pool

The new pool at Opelousas is practically completed, and will be available to the public in the summer when a new park, being built on reclaimed brush land, is opened. In the new park, in addition to the pool, will be a community center, a nine-hole golf course, two tennis courts and several barbecue pits.

The new pool is 120 feet long and 60 feet wide. The source of water supply is a nearby deep well. The pool, which has a capacity of 190,000 gallons of water, can accommodate 500 swimmers. Adjoining the swimming pool is a wading pool for children, which is 25 feet square. The concrete bathhouse is 134 feet long and 22 feet wide, providing 32 lockers for each sex. Lighting is by twelve reflectors mounted on six overhead light standards.

Spring Housecleaning at the Sewage Treatment Plant

With the appearance of these spring-like days the spring housecleaning season is at hand at the sewage treatment plant. During the past three months or so, certain little things have had to be left undone but now with the approach of warmer weather is the time to get plants in first class operating condition. The winter's accumulation of sludge will need be disposed of and sludge beds cleaned off and raked ready for the load which they must soon receive. Possibly there is an accumulation of rubbish and refuse at different points around the plant. This should be disposed of before warm weather arrives. The trickling filter will soon have its regular spring sloughing stage. Check the underdrains to see that they are open and ready to accommodate this increased quantity of solid material. The floating sludge in the gas vents of the Imhoff tank has probably been frozen during the winter. This should be broken up to allow the sludge to resettle and the accumulated floating material should be removed and burned or buried. A few shrubs and trees, together with a nice lawn, will attract more visitors. This is particularly desirable because if the public realizes what the sewage treatment plant does and its very important part in creating a sanitary environment, funds for its support and maintenance will come more easily. Why not start a plant beautification program this spring.

The above is probably old stuff, but nevertheless it seems to be an appropriate reminder.—South Dakota "Clarifier."

Spray Nozzles to Remove Imhoff Tank Scum

In service in sixteen 4-bay Imhoff settling tanks at the city of Cleveland's Westerly sewage treatment plant, are a total of 1,360 Link-Belt spray nozzles for automatically skimming the scum off the surface of the tanks, as illustrated in the pictures herewith, and for propelling it along to the scum boxes located at one end of the tanks.

The fine sheet of water coming from the nozzles strikes the surface of the tank at a tangent and imparts motion to the particles on the surface. As the length of the tank is too great for one row of spray pipes to move the scum through the entire length, a series of pipes was put across the tanks. The force of the water jet is sufficient to move the scum in front of one set of spray nozzles into the zone of influence of the next set of nozzles. In this manner, the scum is flushed along to the end of the tank, where the scum boxes are located.

In order to propel the scum accumulating at the end of the tank, to the lips of the scum box, located at one side, it was necessary to install one spray pipe in each bay, with nozzles at right angles to the other spray pipes. The illustration shows the method of installation.

Sewage treatment tanks at Cleveland, Ohio, Westerly plant, showing series of spray pipes with Link-Belt spray nozzles for flushing the scum on surface onward to the lips of the scum boxes at end of tanks.

The Editor's Page

Modern Highway Equipment Has Lowered Construction Costs

Over the past fifteen years there have been quite remarkable reductions in the costs of highway construction. In North Carolina, the state highway engineer reports that common excavation, which cost 50 cents a yard in 1920-23, cost only 20 cents a yard in 1939; similarly, borrow excavation has been reduced in the same period from 40 to 20 cents, concrete pavement from $14.00 per cubic yard to $8.75, 18-inch reinforced concrete pipe from $2.12 a lineal foot to $1.53, and reinforcing steel from 5.88 cents a pound to 4.82 cents. Further, he says that similar reductions are general all over the United States, according to the Public Roads Administration.

In other words, we are getting a road today for about half what the same type of road cost 15 or more years ago; as a matter of fact, we are getting a far better road, because engineering also has improved and our highways today are smoother, safer and better able to stand the wear and tear of traffic and the elements.

Three groups are responsible for this lower cost—the highway contractor, the manufacturer and the engineer. Their vision, resourcefulness, courage and determination to improve their product, their design or their output are saving the taxpayers a lot of money.

Snow Removal Costs and How They Are Paid For

It is generally assumed that the costs for snow removal are covered, so far as the states are concerned, by the extra income derived from gasoline sales, and that the many other benefits that accrue from keeping our highways open are practically net profit. These other benefits include better retail business, earlier payment of automobile license fees, assured medical service, fire protection, and many other similar items.

It is doubtful, however, if gasoline tax income is sufficient under all conditions to meet the costs of snow removal. Conditions vary greatly. In the north east and north central states, automobile travel would practically cease in the snow periods unless highways were kept properly plowed—that is made safe for travel. Under such conditions, snow removal pays its way directly.

California appears to furnish a different problem, as figures recently presented by the state maintenance engineer indicate that on neither main line or recreational roads will gas tax income cover the cost of snow removal. On main line roads, the cost of snow removal per 1000 vehicle miles over the past three years has been $4.06, whereas the income to the State Highway Department has been estimated to be only $1.11 per 1000 vehicle miles. On the recreational roads, the cost of snow removal has been $11.02 per 1000 vehicle miles, as against the estimated gasoline tax income of $1.11.

These California figures refer, so far as income is concerned, to traffic generated on the road mileage actually cleared of snow, and take no account of the considerable volume of traffic through the area which is induced by the fact that the roads are open.

But whatever the figures show, and no matter how much the cost, the traveling public, which is pretty near everyone, would certainly rise in violent and bitter protest if roads went unplowed. Snow removal and ice control is now one of the accepted "musts" of highway work.

Some Facts Regarding Contract and Force Account Construction by Counties

In a recent survey by the Editors of this magazine, reports on highway construction practices and methods were received from 586 counties. One of the questions asked involved information regarding the amount of highway construction by force account and by contract. A preliminary summary of the information shows that of the 586 counties, only 82 carried on graded earth road construction by contract. These were concentrated principally in two or three midwestern states.

On gravel roads, the figures did not change materially, only 92 carrying on construction by contract, and these also were mainly in the same group of states mentioned before. In the case of higher-type roads, there is a definite swing toward contract construction, but it is still a small proportion of the work. Surface treatment work was reported by 170 counties, in 42 of which the work was done by contract. Mixed-in-place work was carried on by 136 counties, of which 40 reported that work was done by contract. Of 33 counties reporting laying of plant-mix, 16 stated that the work was done by contract.

A full statement of the results of the survey covering the above 586 counties and a number of others which have forwarded reports since the preliminary tabulation was made up will be published in an early issue.

Changing Trends in Water and Sewage Treatment Plant Design

It is now quite generally recognized that a treatment plant, whether for water or for sewage, cannot be economical and efficient without the use of modern equipment. The inventors of this equipment had to come up the hard way, overcoming prejudice and inertia on the part of engineers who felt that, not only was the old way good enough, but that the spending of good money for patented equipment wasn't just the right thing to do. It is with unusual pleasure, therefore, that we note on another page of this issue the award, to two leading inventors of sanitary engineering equipment, of silver plaques as modern pioneers of industry. We believe it is quite significant that this important field of sanitation is now at the point where it rewards the men who can devise better and more efficient equipment. That being the case, we can look forward confidently to still more progress.

Adequate Street

By JAMES S. BURCH
Engineer of Statistics & Planning, North Carolina State Highway Commission

THE purpose of traffic signs is to convey to the driver some message directly related to his driving operation, such as: To inform the driver where he is, i.e., on a certain route; the direction and distance to his destination; to remind him of his responsibility; to inform him of special conditions, and to indicate the need for caution, or the application of certain laws.

Naturally, the sign is of no value, unless it can be seen and understood; and there is need for improvement unless the sign is obeyed by at least a majority of the drivers. Thus, the major properties of a good sign are:

1. Visibility; involving proper position, size, color combination and illumination in dusk and dark conditions.

2. Simplicity; involving the fewest possible number of short words or symbols, quickly and easily understood by all drivers.

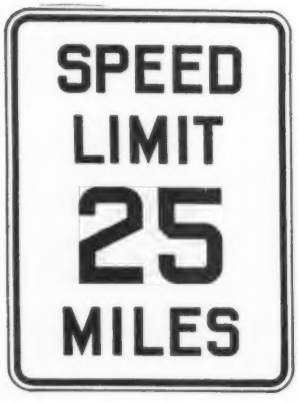
3. Uniformity; involving identical signs for identical situations, regardless of where these situations may occur; consistent positions, standard shapes, sizes, colorings and legends.

The sign should not be placed unless it is really necessary. As an example, the "Stop" sign is undoubtedly the most overworked sign in use today. This sign involves an extreme inconvenience factor, is generally objected to by the driver, and it will not be obeyed unless it is obvious to the driver that a stop is necessary. The decision as to whether a Stop sign should be placed or not involves a careful study of the intersection; and its need may be determined by a certain process which develops a figure for the "critical safe speed" and involves sight distance, brake distance, and approach speed. The establishment of a through street or boulevard does not always justify the placing of Stop signs against every entering street. The unnecessary use of any regulatory or warning sign will lead to its disobedience; and disobedience of that sign will encourage disobedience of all other such signs.

Having determined whether or not a sign is needed, the next question is *"What sign is needed?"* It should be remembered that all traffic signs have been standardized, and that each of these signs has one purpose, and only one purpose. For the last 10 years or more, all highway signs in all states have followed a definite and rigid set of standards, with few exceptions; and the driver has learned these and follows them automatically. The highway driver of the morning is the city driver of the afternoon and vice versa. If he is given the same sign standards in the cities as on the highways, he will recognize them as old friends and reliable advisers; and the chances for automatic obedience are considerably increased. If, on the other hand, we use non-standard signs, as regards position, size, color or legend, our driver is not so prone to recognize these signs, and immediately questions their authority and reasonableness.

Standard proportions of letter sizes, strokes and spacings also have been worked out for quick, clear reading; the wording on traffic signals should in general have a minimum height of 4 in. or 5 in. The word Stop is 6 in. high. The smaller signs naturally employ smaller lettering.

Illumination: All Stop, Slow, Speed Limit, and Railroad Warning signs should be illuminated at night to be visible for all distances up to 350 feet, and



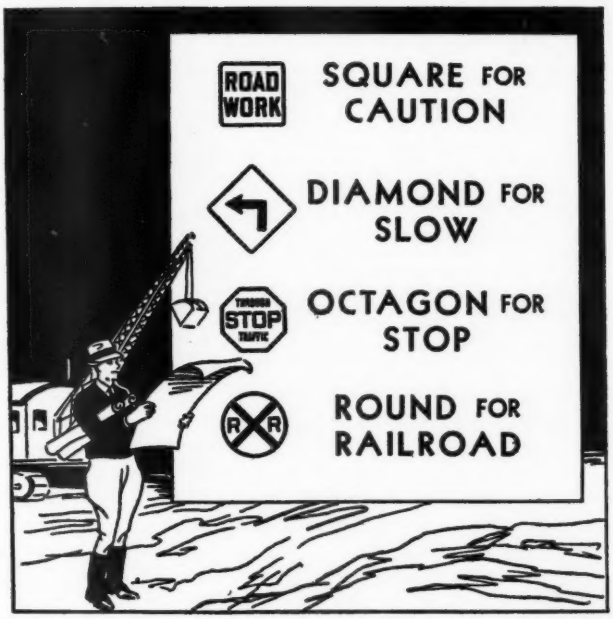
Traffic Signs

Important factors in the selection, location and placement of street traffic signs are discussed; signs for night traffic

certain words should be outlined in white illuminated units. Flashing red self-illumination may be used in the lettering on Stop signs. However, if the letters Stop are in white, it is recommended that there be provided a red element by auxiliary red reflectors. It should be remembered that larger signs are needed for high speed traffic, or where the message is unduly long. Because of the increased speed on our highways, we have already started the use of oversize signs and letters in special cases, and it is probable that this policy will have to be extended materially in the years to come. For instance, at a 60 mile speed, tests have shown that letters of less than 6 in. height cannot be read by a driver within his gross braking distance in daylight, or less than 8 in. letters at night. A rule-of-thumb rule is about 50 feet of legibility distance in daylight for each inch of letter height, using wide series D letters (Forbes-Holmes, Yale).

Sign locations: Since the primary purpose of sign design and placement is to obtain visibility with ease, the location of the sign is of special importance. The careful driver focuses his vision some distance ahead of his car, and thus, he does not really see nearby objects. For instance, under ideal conditions at 30 miles per hour, his stopping distance is about 90 ft. The prudent driver at this speed will maintain his vision at least 90 ft. ahead; and if we are going to give him a message, we must expect him to read it when he is not further away from it than 90 ft. at this speed. It should be remembered that, 90 ft. at 30 miles per hour amounts to only *two* seconds; and, in this short time, he must get the message, decide to act, and complete his action.

We should also remember that a driver cannot look two ways at once. We know that he must look to his left immediately before entering an intersection, and we



should place our sign on his right, with a sufficient visibility distance for him to understand the sign message before he has to look to his left. The position of the sign is, therefore, governed by the prevailing speed of the approaching driver, and by the sign message upon which we expect the driver to act. The following are minimum requirements:

Stop signs are placed at the crosswalk, or if there is no crosswalk, then not closer to the intersected street than 30 ft. Stop signs at railroad grade crossings are placed not closer than from 15 ft. to 50 ft. from the nearest track. Stop signs at deadend streets are placed in the center of the street (and by all means should be illuminated for night operation). Generally, Stop signs are placed at the point where vehicles are expected to stop.

Parking Prohibition signs are placed at the first and last points where the requirement is effective, and at intervals of about 100 ft., where the prohibition is continuous for some distance.

Railroad Crossing signs are placed 15 ft. from the nearest track, and Railroad Advance Warning signs are not closer than 100 ft. to the nearest track. The placement of this sign should depend on the approach speed of cars and other local factors.

Slow and Caution signs are placed at the official braking distance for prevailing speeds, but not closer than 100 ft. from the hazard. At 40 miles per hour, the official braking distance is 137 ft.

To avoid damage from overhanging trucks, etc., no part of any sign should be closer to the street than a point 12 in. behind the curb line.

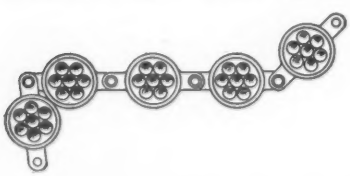
Height: In rural areas, signs are placed with their centers 3½ ft. above the pavement. In urban territory, wherever there is a raised curb, the sign center is placed 8 ft. above the pavement, so that it may be seen above parked vehicles. This sign height has been found to be satisfactory for the use of modern reflecting elements. Wherever oversize signs are used (i.e., more than 24 in.), the bottom of the sign should be 2½ ft. above the pavement. Where large trucks of considerable height are accustomed to park, signs will be hidden, and suitable parking restrictions should be applied to render signs visible at all times.

Maintenance: Proper sign maintenance requires constant attention and activity. Due to deterioration, vandalism, and changing conditions, it is probable that annual sign replacement may be in the order of from 15% to 30%. Dingy, dull, streaked, or rusty signs do not command obedience, and, incidentally, are poor advertising for a progressive community. Damaged or destroyed signs should be replaced in 24 hours, and all employees of the city government should be instructed to report damaged signs to the city's traffic department. Signs should be cleaned and repainted at least once each year. Brush, weeds and limbs, which block visibility, should be removed. Signs which do not apply should be removed at once, and this applies especially to detour signs, men working signs, etc.

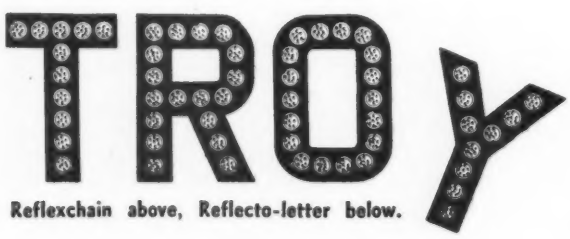
Signs at night: A sign perfectly adequate in daylight may be a total loss at night; and most accidents occur from 6 to 11 p. m. This is especially true at street intersections, where the street light is in the center of the intersection, and only the back of the sign is illuminated. We should use reflecting units on all signs which we expect to be obeyed, and at least the major word should be reflectorized or illuminated. Many new improvements along this line are on the market.

Conflicting signs: All conflicting privately owned signs should be discouraged and removed. Special trouble is noted in this respect around filling stations, curb service stores, etc. In fact, we have sometimes noticed a sign out on the curb, reading "Stop For Joe's Weiners" in standard shapes and colors. Quite often, city officials put up conflicting signs. I have seen a Stop sign at an intersection with a Stop and Go light; and, when the light is green, the driver must either disobey the Stop sign, or the green light. We have seen cases where there are no speed limit signs whatever inside the town, but when the driver approaches the rural section, he will encounter a sign reading, "Speed Limit 25 M.P.H." We have seen other cases where the city is attempting to enforce varying speed limits with no speed limit signs anywhere in evidence. We must play fair with the driver if we expect him to pay any attention to our signs and restrictions.

This material was presented by Mr. Burch at the Raleigh, N. C., Short Course for Street Superintendents and Assistants.



These cuts courtesy Traffic Equip. Division, Aeroil Burner Co.



Reflexchain above, Reflecto-letter below.

Sterilization of New Deep Wells

New deep wells are frequently polluted during the process of drilling. This pollution, unless destroyed by sterilization, sometimes persists for weeks or even months after a well has been put in operation and interferes with the interpretation of results of bacteriological tests. As it is important to know the true quality of water delivered by new wells it is wise to sterilize these after all construction work has been completed and before bacteriological samples are collected. This sterilization can be accomplished as follows:

Dissolve about one pound of chlorinated lime (fresh) or similar compound such as H. T. H. in approximately two gallons of water, breaking up all large lumps.

Pour about one gallon of this solution into the outer well casing, flush down with clear water, start the pump and pump to waste until a positive test for chlorine is obtained in the pump discharge.

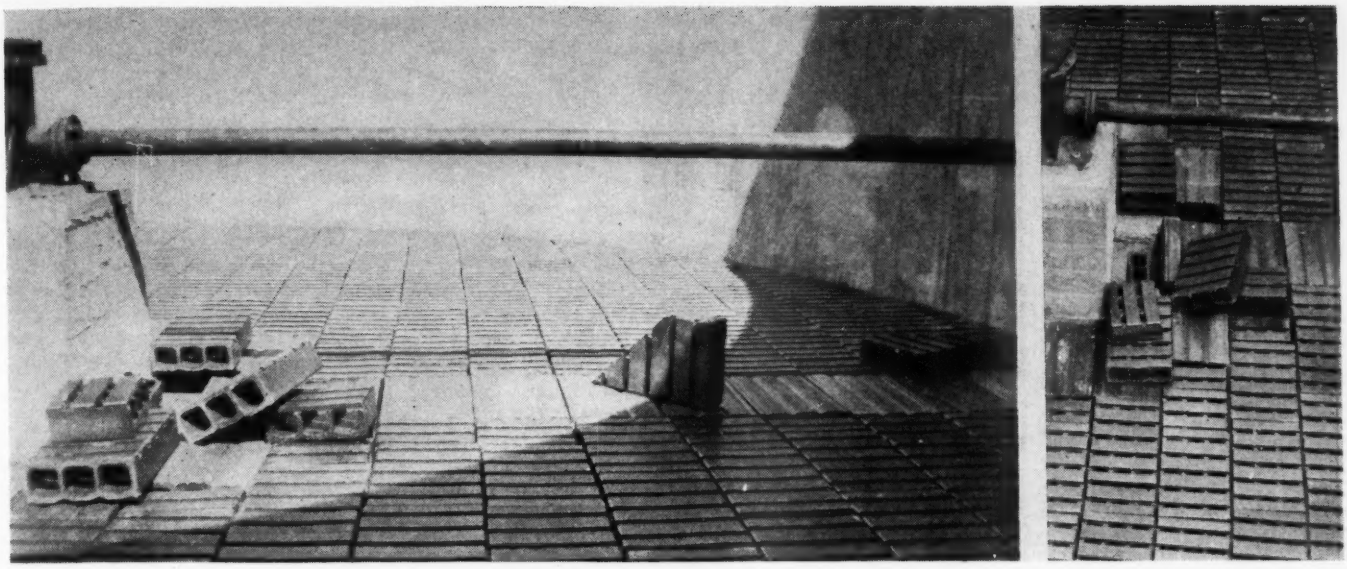
Pour the remaining chlorine solution into the well as before and allow to remain for several hours, over night if possible, and then pump the well to waste until a test with othotolidine shows that all traces of chlorine have disappeared from the pump discharge.

If the above directions are followed carefully a bacteriological sample collected one hour after all traces of chlorine have disappeared should be representative of the underground water entering the well. However, occasionally more than one sterilization is necessary to rid a new well of the contamination introduced in the construction process.—"Drippings from the Georgia Faucet," published by Georgia Water & Sewage Assn.

Divining Rod Phenomena Study

They take the divining rod seriously in England—so seriously that there is a "British Society of Dowsers," and several serious books have been written on the subject. In fact, the latest contains a 4-page bibliography.

This latest book—"The Physics of the Divining Rod"—is by two authors whose authority is suggested by the initials after their names—B.Sc., A.R.S.C., F.R.A.S., M.A., F.R.S.E. They believe that they have established the physical basis and the utility of dowsing. They claim to show that, "the causes of the ordinary dowsing reflexes and rod reactions are to be found in certain penetrating, electrically excitary rays, one class—the more important of the two—consisting of short Hertzian waves of geophysical or cosmic origin, and exhibiting polarisation and electromagnetic phenomena." They admit that in some instances, as when dowsing is performed at some distance over a map, or when lost persons or corpses are traced by diviners, a cryptopsychic faculty, allied to clairvoyance and telepathy in physic science, may be utilized.



Cannelton "Translot" blocks, showing construction and mitered piece

Trickling Filter Design, Construction and Operation

The second of a series of articles. This discusses important factors in underdrainage and ventilation and describes underdrainage units

PROVISION should be made at the bottom of the trickling filter for removing the sewage continuously, as it percolates through the bed, and also for an adequate flow of air in or out through the filter media. This provision should be made over the entire bottom, with at least one opening, and preferably more, of adequate size for each square foot for each purpose. It is not necessary to provide two systems of conduits, one for drainage and one for ventilation, as the same system can be used for both, the liquid occupying the bottom of the underdrainage system and the air the upper part.

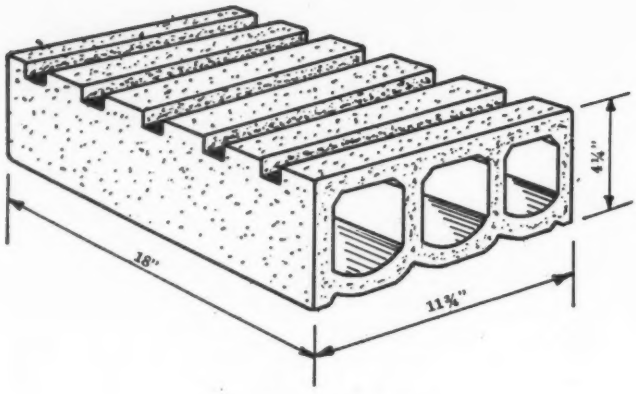
The floor of the filter is laid with a slope toward a central drainage channel or channels. It is standard practice to lay on this floor parallel underdrainage at right angles to the central drainage channel and extending the entire width of the filter. These underdrains must have sufficient capacity to permit them to drain the filter at the maximum rate of flow and, at the same time, furnish the air that is necessary for ventilation. They must also have ample openings, frequently and evenly spaced, to permit air to enter the body of the filter and the effluent to drain from it.

If the system of such underdrains leading from the perimeter of the filter to the main drainage channel be considered as divided into strips 12 inches wide, then each strip should be adequate to serve the area of bed immediately above it. In the case of a circular bed 100 feet in diameter with a central channel, the longest strip would be 50 feet long and 50 sq. ft. in area. The underdrains channel or channels lying in this strip should have the capacity necessary to serve this strip. The comparatively high rate of 3 million gallons per acre per day (high for standard rate filters) is approximately 0.05 gal. per sq. ft. per minute, or about 2.5 gals, for such a 50-ft. strip—about 0.006 cubic feet per second.

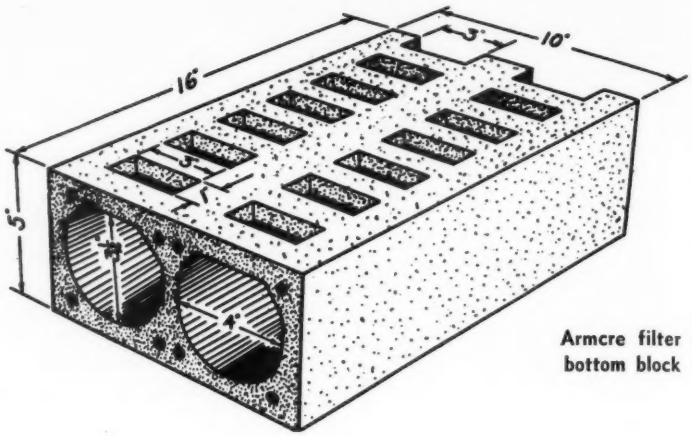
Thus from a strictly drainage viewpoint, a small drainage channel is sufficient, but small openings tend to clog from deposits of suspended solids or from organic growths, and are difficult to flush or clean. Much greater area is desirable; but most desirable and necessary of all is the presence of ample and well spaced openings in the floor of the filter to permit access of air to every portion of the filter bed.

There are few reliable data to determine the area of openings required for adequate ventilation. Most recent trends point to the strong desirability that these openings should equal 20% of the floor area of the filter, or 28.8 square inches per square foot.

Until a few years ago a common type of construction was to lay, on the concrete floor, inverted split tile in 2-ft. lengths, separated an inch or more at the joints. These were placed in parallel lines, either covering the entire floor or spaced several inches to several feet apart. The usual size was 4-inch or 6-inch split tile. If 4 in. tile be laid in lines 6 inches on centers, with staggered joints, this gives one joint opening in each area of a little over one square foot. With joint openings 1¼ inches wide, the area of opening provided at each joint is only 7.2 square inches. Using 6 inch split tile, the area of joint opening per square foot of bed would be about the same, but the area of bed served by a single joint would be at least 1-1/3 to 1½ sq. ft. Any stoppage of the joint, even partial, would reduce the capacity of the lines to furnish air to the filter bed considerably below any safe minimum. Some improvement is obtained by blocking up the half-tile at each end, thus raising them a small distance—a half inch or so—from the floor. This construction permits the sewage to enter through these bottom slots, but does not materially increase the area of the openings through which



Cannelton "Translot" block



Armcre filter bottom block

air may enter the filter and is an inadequate type of construction.

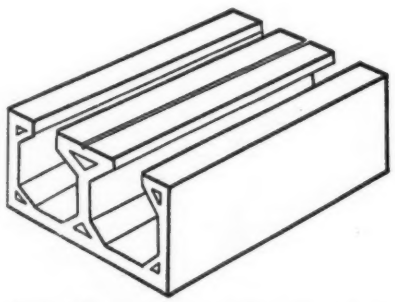
In another type of construction the concrete floor is cast or poured as a series of parallel channels and ridges, the former being spanned by slotted slabs or grill blocks, usually of vitrified clay. These afford good ventilation, but the cost of constructing a floor of this type is considerable, and obtaining accurate grades in the channels is difficult.

A marked improvement on either of these is a complete conduit system, designed to provide ample area both for carrying off the filter effluent and for passing air into the filter, several designs of which are manufactured by a number of producers of vitrified clay products. Such a system consists of a number of vitrified clay units laid directly on the concrete floor, either on a thin layer of grout, on a very thin bedding course of sand or directly on the concrete. Such systems are simple and economical to install.

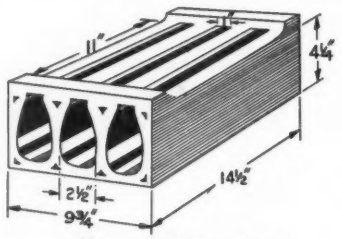
The units furnished by most of the manufacturers are in the form of a quadrangular prism pierced by two or more ducts and having a number of openings in the upper face. These are so laid as to cover the floor of the filter completely, and form continuous underdrain channels having the same grade as the floor on which they are laid. The perforated tops form a continuous support for the filter media over the entire area of the filter. Among the makers of these blocks are Ayer-McCarel-Reagan Clay Co., Brazil, Ind.; Bowerston Shale Co., Bowerston, O.; Cannelton Sewer Pipe Co., Cannelton, Ind.; W. S. Dickey Clay Mfg. Co., Kansas City, Mo.; Metropolitan Paving Brick Co., Canton, O.; National Fireproofing Corp., Pittsburgh, Pa.; and Universal Sewer Pipe Corp., Cleveland, O.

All of the units furnished by these firms are made of vitrified fire clay or shale, similar in material to standard sewer pipe.

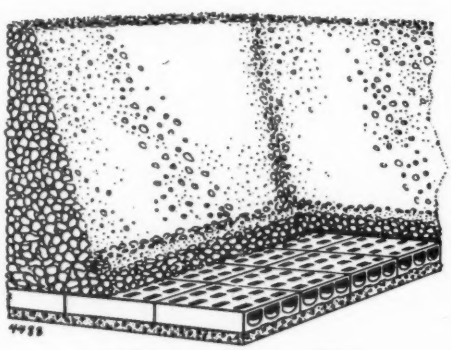
The "Armcre" filter bottom block (made by Ayer-McCarel-Reagan Clay Co. and by the Bowerston Shale Co.) is 16″ long, 10″ wide and 5″ high. Lengthwise through it runs two ducts, approximately circular in section and 4″ in diameter, which have an area of 12.5 sq. in. each. This gives a combined conduit area of 30 sq. in. per foot of width. Each block has in the top 14 apertures, each approximately 3″ x 1″, or a total of 38.5 sq. in.—equivalent to 34.6 sq. in. per square foot of floor area, or about 25% of the total area. The blocks weigh 28 lbs. each.



Mono-Unit Type Metro Filter Floor System



Natco Unifilter tile



Dickey Underdrain in a Filter

The Cannelton "Translot" filter bed block is 11¾″ wide by 18″ long and 4¼″ high. Each block contains three ducts, each approximately 3″ high and 3⅛″ wide, with segmental bottom and vertical sides; giving about 24 sq. in. area per foot of width. Across the top are five channels, each about 1″ wide and extending down to the tops of the ducts, giving a total area of top openings of approximately 45 sq. in., equivalent to 30 sq. in. per sq. ft., or 21% of the area. The blocks weigh about 32 lbs. each.

The Dickey filter bed block is 11¾″ wide by 18″ long by 4¼″ high. Each block contains three ducts, the bottoms of which are semi-circles 3⅛″ in diameter, continued with vertical sides 1-7/16″ high, with flat tops. This gives a total area for the three ducts of about 25 sq. in. In the top of each duct are ventilating slots which provide openings of about 29 sq. inches per sq. ft., or about 20% of the total area.

The Metropolitan "Mono-Unit" filter block (the company also makes another type, the "Metro," which differs from these and is described later) is 10″ wide, 12″ to 18″ long and 5″ high. It contains two octagonal channels, 4″ wide by 3½″ high, giving a combined area of about 23 sq. in., equivalent to 27.5 sq. in. per foot width. A continuous slot in the top, over each duct, 1½″ wide, gives a total area of top opening equivalent to 30% of the top area, or 43.2 sq. in. per sq. ft.

The National Fireproofing Corp. makes the "Natco Unifilter" block. This is 14½″ long, 9¾″ wide, and 4¼″ high. It is pierced with three egg-shaped ducts, each 2½″ wide at the widest part and about 3½″ high, giving a total area of about 22 sq. in., equivalent to about 26 sq. in. per foot width. There is a continuous slot 1″ wide at the top of each duct for 11″ of its length, giving 33 sq. in. area for the block, which is just a square foot in area. At each end of the block, the top is reinforced with a strip 1¾″

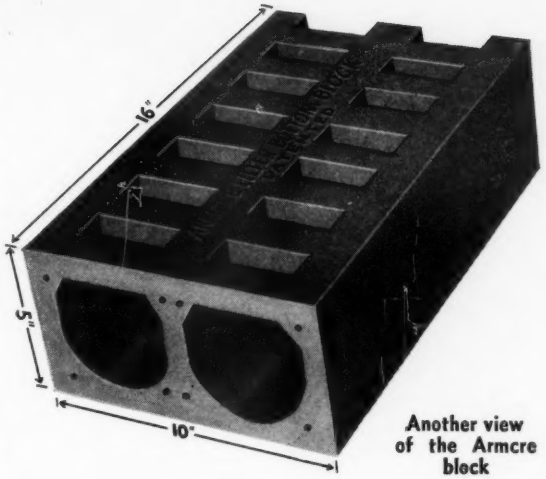
wide and about an inch thick, integral with the rest of the block.

The Universal Sewer Pipe Corporation makes the Aerodrane Block. It is a single-unit, double-channel block with slotted, arched covers over each effluent channel. The channels are essentially egg-shaped, parallel, bonded together with a common base which extends upward for about one-quarter of their heighth. The block is 18″ long, 12″ wide, and 6″ high. Four vertical slots, 1″ in width, are cut transversely across the arched covers of each channel, extending down to approximately one-half of the depth of the channel. A fifth slot is formed when the blocks are laid end to end by transverse cuts at each end of the block. The area of outflow openings is 25 square inches. The area of inflow openings is 52 square inches, or 32% of the top area of the block. The vertical slots permit the entrance of both effluent and air into the outflow channels.

The Metropolitan Paving Brick Co. makes also a two-unit floor system called the "Metro." This consists of two forms of units, the "channel block," which forms, when assembled on the filter floor, a series of parallel channels; and the "grill blocks" which bridge these channels and support the filter stone. The channels so formed have rounded bottoms, are 11″ wide at the top and 3″ deep, with flat surfaces 2½″ wide between them to serve as seats for the grill blocks. The area of each channel is about 30 sq. in., equivalent to about 26 sq. in. per foot of width. Each grill block is 13½″ x 6¾″ by 3″ deep, and contains six slots each 5-5/16″ x 1⅛″. This gives a total slot area of 36 sq. in. per block, or 40% of the area.

All of these blocks have excess strength as regards their ability to carry the load due to the filter stone above. above. Their average resistance to crushing, as shown by standard tests, is around 600 pounds per sq. inch or about 90,000 pounds per sq. ft., whereas the load that may reasonably be expected to come upon them will not exceed 800 or 1000 pounds per sq. ft.

Most or all of the blocks described may be obtained in shorter lengths and with various standard mitered ends to facilitate fitting into the filter bottom. With blocks of this type, it is not necessary to use upright vents at the ends of each line of blocks. However, where it is desired to provide for circulation of air between the lines of underdrain, an air duct cover block is available on which upright vents may be mounted.

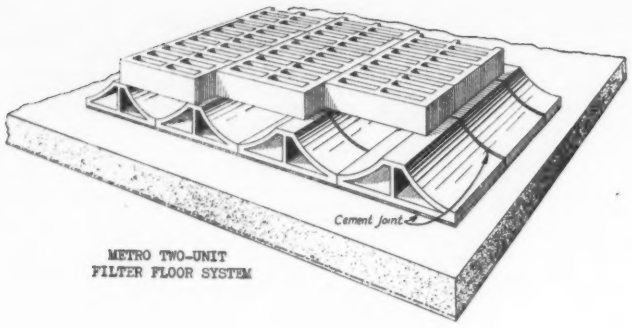


Another view of the Armcre block

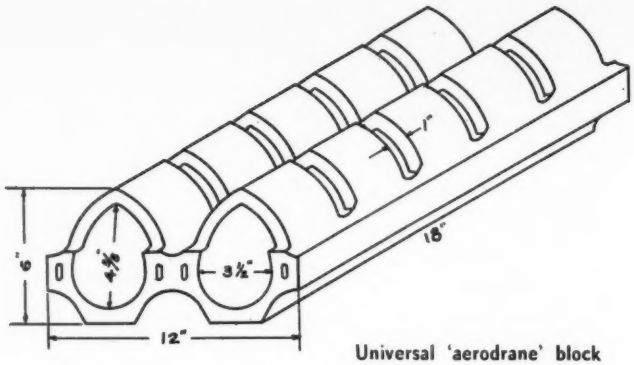
It is apparent that any of the floor systems described, using vitrified blocks, is far superior in ventilating effectiveness to those made with half-tile. In fact, for high-rate filters (to be described later) the use of the special drainage blocks appears essential.

Drainage Channels

The function of the drainage channel is to receive the flow from the underdrains and convey it to a discharge pipe or conduit, and to bring to the



METRO TWO-UNIT
FILTER FLOOR SYSTEM



Universal 'aerodrane' block

underdrains the air necessary for ventilation. It is perferable that this channel be straight and accessible for flushing or cleaning. The grade and the capacity must be ample.

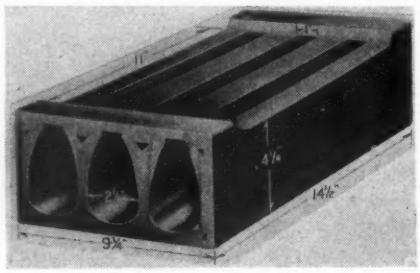
Location is generally along one diameter of the filter, with the floors of the two halves sloping uniformly to it; this is usually preferable to any other arrangement of drainage and requires very little more head. However, for rectangular or very large circular filters, or where every inch of head must be saved, two or more channels may be used. Where a rotary distributor is used without a center drainage well it may be desirable to offset the channel to clear the distributor support. This eliminates the need for splitting, dividing or curving the channel, thus making inspection and cleaning easier. In this construction, the channel has a uniform slope from end to end.

When a center drainage well is used, the channel may be sloped both ways from the periphery to the center and the effluent discharged through a pipe from the center well. Inspection is possible from the center well or from the periphery.

The width, depth, slope, velocity of flow and capacity are closely related. Sufficient capacity must be provided to carry off maximum discharges, and computations should be made to insure that even with these largest flows the channel will have enough capacity to prevent backing up into the underdrains and also sufficient unsubmerged space to provide ventilation.

Theoretically, both the main channel and the branches could decrease in size as they approach their upper ends; but as the velocity of flow in them decreases also, and there would be little, if any, saving in cost, they are usually made uniform in size throughout. The width and depth of channel depend upon its slope and the volume of flow; the slope is dependent upon the head available and upon the velocity desired, which is normally about 2 fps.

At a rate of 3 mgad or approximately 0.05 gal. per sq. ft. per minute, on a circular filter 100 ft. in diameter, the main channel at its outlet would carry 0.7854 x 10,000 x 0.05, or 52 cubic feet per minute or 0.87 cu. ft. per second, which, with a velocity of 2 ft. per sec., would require conduit area of 0.435 sq. ft., or 62.6 sq. in. Allowing for air space and freeboard, the channel should be at least 12 in. wide and about 8 in. deep, as a minimum; a larger channel section is desirable and is often used.



View of Natco underdrain

Center Channel Covers

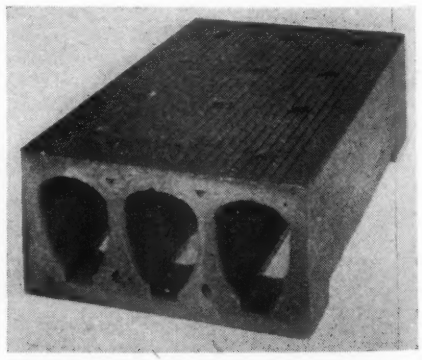
Covers for the center channel must be provided which must serve also as underdrains, draining and ventilating the filter above them. Normally these are placed on top of the underdrain blocks, bridging the channel. Enough overlap is necessary to give good bearing on each side, and care should be taken that the covers are not displaced by the filter medium when it is put into position. Grill blocks can be used for this purpose where the span is not too great. Blocks 3″ deep, 11″ between supports, made for the "Metro" floor, when tested withstood a distributed load of 5,570 to 13,300 lbs. per sq. ft. The same type and depth of block, but longer, could be used for spans of 18″ with a factor of safety of 2 for the weakest block. One manufacturer suggests covering the channel with half tile of the same diameter as the channel; if this is 18″ or more it would permit entrance into the channel for cleaning the ducts or other purpose. Or small half-tiles can be used, laid crosswise of the channel and spaced as far apart as practicable without permitting the filter stone to fall through. These should usually be fixed in place.

Whatever the type of cover used, it must have sufficient beam strength to support the stone above—about 100 to 150 lb. per cu. ft. In the case of large filters it may prove more economical, and will generally save some head, to use two channels, each draining one half of the filter; which channels would have less depth and require shorter cover blocks.

If it is intended to flood the filter for fly control, each channel must be so constructed that it can be closed where it passes through the filter wall, as by use of a sluice gate.

Above the flow section during maximum rate of flow there should be an air section of at least twice, preferably three, times that area. This is to provide air to the ducts, and for this purpose the top need therefore be no higher than the tops of these ducts, since air above this would not enter them. The maximum rate of flow from the filter will be much less than that into the pretreatment units, since the latter tend to smooth out the irregularities of flow, as does also the filter itself. If we assume the maximum flow from the filter to exceed the average by 25%, and plan for an air space 2 to 3 times as great, we have a desired total area of channel 3½ to 4¾ times the submerged area.

If the channel has a semi-circular invert with a diameter between 12″



Natco channel cover block

and 24", as is commonly the case, the slope will normally be between 0.3% and 0.1%, to give a velocity of about 2 ft. per sec. That is, for a filter 100 ft. in diameter, the invert will be 0.3 ft. to 0.1 ft. lower at the outlet than at the upper end. If the invert be made of split tile, the top of this at the higher end of the channel (and every other point) must be below the inverts of the abutting ducts. If these are 3" deep to the invert, the top of the split pipe would be .25 ft. + (0.3 to 0.1 ft.), or .55 ft. to .35 ft. below the top of the underdrain opening; which space, plus that in the split title above water surface, is available for ventilation. If we call this distance 0.5 ft. and assume a velocity of flow of 2 fps., then the diameter of the channel D may be calculated by the formula $2 \times \frac{0.5D + .3927D^2}{4} =$ the flow in cu. ft. per second. If the flow be 0.87 cfs., then D becomes 1.6 ft., or say a 20" half tile. If two channels are used, as suggested above, a similar calculation shows that these could be 12" in diameter instead of 20".

Other Ventilation Details

Some filters are constructed with provision for ventilation at the upper ends of the ducts as well as the lower. This may be in the form of a gallery or large air channel, at the inner foot of the filter wall, across the ends of all the floor ducts and connected to them; which air channel is connected to the outer air by several pipes set vertically against the wall, or by a number of openings through the walls (special "wall ducts" or reducers for this purpose are made by all of the manufacturers listed previously. Or such openings can be made at the end of each duct or group of ducts without the use of the air channel. (One type of such air duct has already been described.) Or a vertical pipe can be connected to the upper end of each drainage channel, though this is a much less desirable method of construction. Under any conditions, if the bed is made watertight to permit flooding, all openings through the wall must be provided with means of making them tight.

The object of ventilation is not merely to draw air *through* the drainage channel and floor ducts, but instead to give air the freest possible access through the underdrains to the under side of the entire bottom of the filter, and thence into the interstices of the filter media. It is possible or probable that a construction which encourages a draft through the underdrains may decrease the upward motion of air from them into the filter. This possibility should be borne in mind when considering the design of any of these details.

Where the drainage channels discharge at the center of a bed, it is customary to place there a well 7 or 8 feet in diameter, extending from the floor to above the filter stone; and to provide two or more channels (as many as 8 were built in one plant) radiating from this and opening into it. The filter effluent which the channels discharge into the well is removed by a pipe laid under the filter floor to the secondary settling tank. The air in the well serves also as a source of ventilation through the underdrain channels into the bed.

Filter Piping

The principal piping in a circular filter consists of the feed pipe to the distributor and whatever piping is required to remove the filter effluent. Provision must be made for draining these pipes to prevent damage from freezing if the filter is put out of operation either intentionally or unintentionally. Otherwise this pipe or the distributor may be burst. In fact, provision should be made, in colder

climates especially, for draining all the piping and to permit cleaning or repairs.

The pipe from the siphon to the distributor usually is carried through the stone two feet or more below the surface; that is, a 2-ft. cover of stone is usually provided. This arrangement simplifies drainage to prevent freezing, as such drains can discharge into the stone. If the pipe is brought in under the filter bottom, special provision for drainage of the riser and the pipe must be made to prevent freezing. The size of the pipe depends upon the volume of flow to the siphon and upon the fall or head available. If the head that is available is a minimum, a larger pipe may be necessary than would otherwise be used. A velocity of 2 feet per second is suitable for pipe design. A 100-ft. diameter filter, operating at a maximum momentary or temporary rate of 3 mgad. would draw about 0.87 cu. ft. per second, which would be readily handled by a 10-inch pipe; however, the rate of siphon discharge is the governing factor, and for the conditions mentioned, and with spray nozzles, the rate of discharge may be and usually is two or three times the average rate of flow. Therefore, a 12-inch pipe would be required. This would handle 1.5 cu. ft. per second with a velocity of about 2 feet per second. In designing, the recommendations of the distributor manufacturer should carry much weight.

Cast iron pipe is ordinarily used for feeds and for distributors, though other materials are occasionally employed. The head is normally small; in filters equipped with rotary distributors it will usually be less than 5 or 6 feet.

With a plant that is running at a fairly uniform rate at all times, protection against freezing is not so important or necessary. But in a plant where very low flows may be expected during the early morning hours, and where winter cold is severe, consideration must be given to prevent damage from freezing. A common method is to provide a bleed-hole in the distributor base or the drain pipe, which is usually small and may be left open on cold nights to protect rotary distributors.

Siphons and Siphon Chambers

Design of siphon chambers is complicated, especially for plants employing spray nozzles. From 6 to 12 feet of head will be required for such plants and a lesser head for plants employing rotary distributors. Further consideration will be given to siphons in the section on EQUIPMENT.

Provision for Fly And Odor Control

Eggs of the trickling filter fly are laid in the organic film that coats the filter stone. Adults hatch out about a week or ten days later. The most effective control is attained by flooding the filter for a period of about 8 hours at 10-day intervals. This drowns the larvae. To permit flooding of the filter the walls must be tight and the effluent channel or effluent pipe must be properly designed. If the effluent is discharged through a pipe, a gate valve is necessary; if through a channel, a sluice gate. The center well type of construction is perhaps best adapted to this.

No special design provisions are required for odor control. Both fly and odor control will be covered more fully under operation.

Post Treatment

The trickling filter removes only a relatively small part of the solids that are applied to it in the effluent from the primary settling tanks—about 25%. It is not the function of the filter to remove suspended matter as much as it is to change the character of the suspended solids. The suspended solids applied to the filter are mainly in col-

loidal and finely divided states, and will not settle readily; the trickling filter, in addition to oxidation, changes the solids to a form that, being heavier and bulkier, will settle if passed through a tank. Therefore, the effluent from a trickling filter should be given post settlement to remove as much as possible of the suspended solids. The extent to which the B.O.D. is reduced depends largely upon the efficiency of removal of the suspended solids; adequate settling is therefore important.

During certain seasons of the year, normally in the spring and the fall, trickling filters "unload," much of the gelatinous film on the stone particles sloughing off and passing off with the effluent from the filter. During the unloading period, the amount of suspended solids in the effluent may be considerably greater than that in the sewage being applied to the filter. Even an efficient secondary settling tank will not remove all of the extra material, but about half of the increased solids matter should be removed by final settling.

The reduction in B.O.D. due to secondary settling is variable, but approximates 20%. Secondary settling tanks are generally similar to primary tanks. The detention period should be from 1 to 1.5 hours.

Sludge resulting from secondary settling following trickling filter treatment is light and flocculent. The usual volume is 500 to 750 gals. per million gallons of sewage, with a moisture content of 90% to 95%. This sludge may be discharged into the influent or, preferably, the digestion chamber of an Imhoff tank; to the inlet of the primary settling tank to settle with the raw sludge, or to the digester.

Results of Treatment

In connection with preliminary and final settlement, trickling filters, if well designed and properly operated, will produce an effluent containing from 35 to 40 p.p.m. of B.O.D., about the same of suspended solids, and perhaps 4 or 5 p.p.m. of dissolved oxygen. As tested by the methylene blue method, a relative stability of perhaps 80% to 85% is normally obtained.

Reports from 16 trickling filter plants in New Jersey (Forman and Shaw) showed a normal reduction in B.O.D. of the primary tank effluents of 72% before final sedimentation. The average overall reduction of B.O.D. in primary settling, trickling filter and final settling was 84.2%; the lowest reduction accomplished was 58.5%, and the next lowest was 63.5%; all others a reduction in excess of 78%.

The average B.O.D. of the raw sewage of these 16 plants was 303 p.p.m. With an average reduction of 84.2%, the average effluent (from the complete treatment process, including primary settling, trickling filters and secondary settling, but before chlorination) had a B.O.D. of about 50 p.p.m.

The average reduction in suspended solids at the 16 plants was 61.5%. The average suspended solids of the raw sewage at these plants was 188 p.p.m., so that the average suspended solids in the effluent from the secondary settling tanks was about 72 p.p.m. Dissolved oxygen in the final effluent averaged 4.3 p.p.m.

It is difficult if not possible to compute any constant and standard relation between B.O.D. and relative stability. Many of the plants showed relative stability ratings of 90%; others were low, with some around 25%. The average of the 16 plants was about 72%. Of the 16 plants, 10 were about 80%. These same plants showed an average effluent B.O.D. of 37.5 p.p.m., with the highest at 58.0 p.p.m. and the lowest at 14.2 p.p.m.

Results from seven relatively large plants, presented in Bulletin No. 132 of the Public Health Service, showed an average B.O.D. of the influent to the trickling filters of 77 p.p.m. and of the effluent from the filters 17 p.p.m.; representing a reduction in B.O.D. of 78%.

Fred E. Smith

Six Ways to Improve

By FRED E. SMITH
Chemist, Water Department, Cambridge, Mass.

COMMUNITY good will is earnestly solicited today by every business enterprise. Advertising, sales policies, and public relations are directed to the purpose of securing and maintaining the interest of those whose patronage is necessary for the continued existence of the business.

In the field of public utilities, the gas, electric, and telephone organizations have for some time assigned funds and personnel to departments of public relations, and thus have achieved a distinct advantage over the most important public utility—water supply—in creating consumer interest and good will.

In large cities the public possesses little information concerning the source and treatment of the community water supply. There are many reasons for this. Supply reservoirs are often located several miles from the city; the filtration plant may be inconvenient to reach also; the distribution system is underground; and interior house piping is concealed within the walls. The tap in bathroom or kitchen is the only indication that water is available at all times.

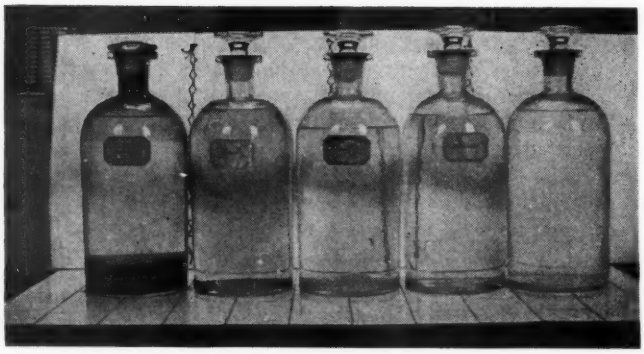
A privately-owned water company may devote time and funds for public relations purposes, and many companies have presented programs publicizing their work. On the other hand, it is difficult for municipal water departments to expend funds for the purpose of publicizing the merits of the community water supply. Local ordinances would not permit the expenditure of funds for this project.

It is possible, however, for a municipal water department to develop a public relations policy without recourse to paid advertisements. Ways and means to accomplish this purpose are available in the several divisions of the department. This article will deal principally with the role of the filtration plant in the field of public relations. Other phases of the water department will be mentioned, because in any publicity program the efforts of each unit must be correlated with the general policy of the department.

Contacts Through the Business Office

A public information procedure may be instituted in the business office, which, unlike the filtration plant or pumping station, is often situated in the City Hall. This office is the division of the department which has most contacts with the public, either directly or by mail. This advantage should be utilized in the interest of departmental publicity.

Many articles have been published describing bookkeeping procedures, billing practices, and personnel training which have proved efficient in expediting business transactions with the public. For the purpose of department publicity, water bills and other communications mailed to consumers could be used to convey information describing the work of the department. A small leaflet of condensed information could be enclosed in envelopes containing water bills. The reverse side of bills would serve for printing brief statements referring to features of the local water supply. For instance, locations of the filtration plant and supply reservoirs might be listed with public invitation to inspect these places. In this manner every contact with individual consumers will be used to disseminate department information which would be of public interest.



Prepare exhibits to demonstrate laboratory procedure

In a city it frequently becomes necessary to acquaint people with the fact that the community drinking water is safeguarded by filtration and other treatment. The plant is rarely mentioned in the public press after it is built. The plant may be located in an outlying section of the community, lessening the possibility of numerous visitors. At Cambridge the plant is located in Kingsley Park, adjoining Fresh Pond. Many people participate in the recreational opportunities available in the park. This source contributes to the number of visitors who inspect the plant.

Demonstrating the Filter Plant

The methods used to demonstrate the Cambridge plant to groups of visitors have been described in the December, 1939, issue of PUBLIC WORKS. Individual visitors receive as much and as careful attention as do classes which visit the plant by appointment. They are provided with a printed card describing the methods of water purification. Explanations of plant features and laboratory tests are given. Reception of visitors will have considerable influence upon the attitude of the community toward the plant. The individual who has been pleasantly received and is favorably impressed by the operations demonstrated for him is a source of good will, the development of which is worth while. In some cities there are conducted annual inspections of the filtration plant to which the public is invited through the medium of local

Water Department Public Relations

In this article Mr. Smith tells why public relations are important in any water department, and gives definite procedure for cultivating the good will of the public.

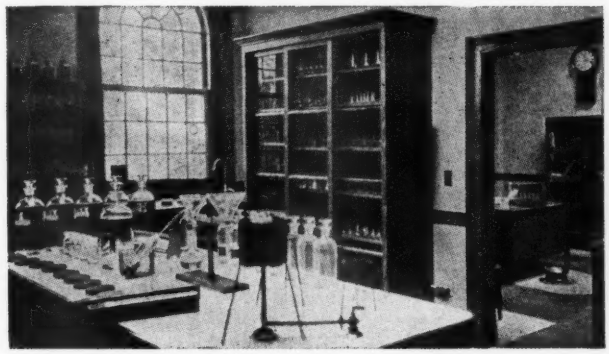
newspapers. These events illustrate the importance of the plant in publicizing water department activities.

The value of the laboratory in the control of water purification is well established. The laboratory is also of importance in connection with a public relations policy. Communications dealing with water analysis and any complaints of unsatisfactory water are usually referred to the laboratory for disposition.

Handling Complaints

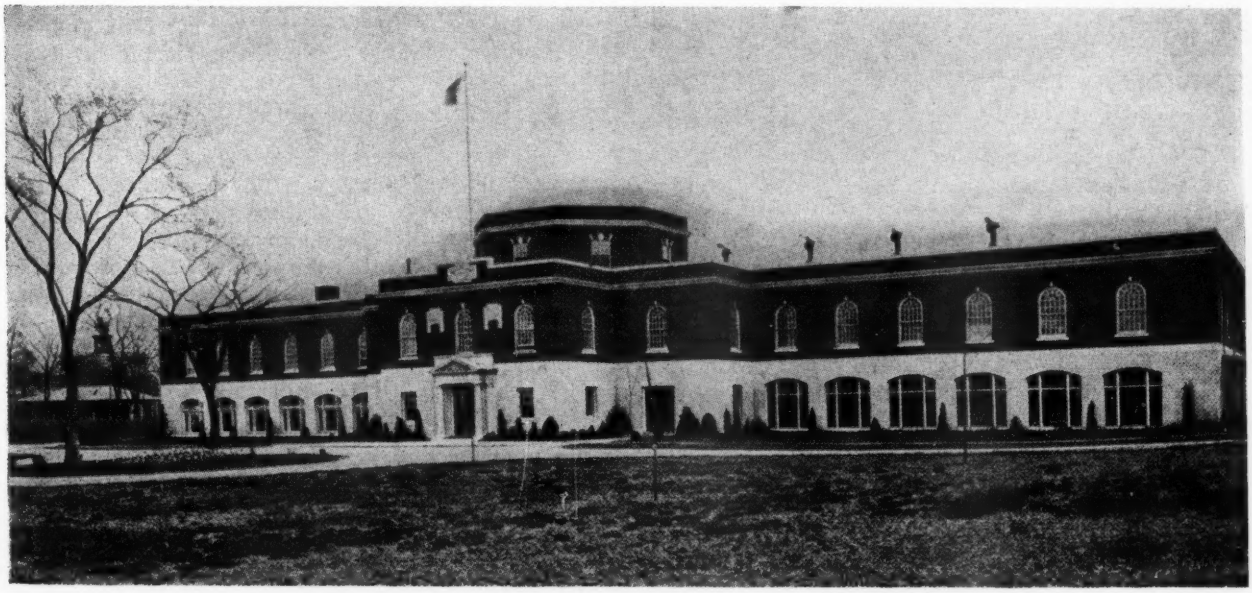
Complaints concerning water quality may be divided into two classes, general and individual. A general complaint would be caused, for instance, by unpleasant taste or odor due to the presence of microscopic organisms in the supply reservoir. Algal growths occur frequently in water supplies and cause dissatisfaction and complaint whenever the taste or odor become noticeable to consumers. This type of complaint will be city-wide in scope and will continue until remedial measures have corrected the unsatisfactory condition.

It is obvious that the best method to avoid such general criticism of the community water supply would be the prevention of unpalatable water reaching consumers' taps. This practice is used at Cambridge by switching sources of supply. The affected reservoir can then be treated with copper sulfate to kill the organisms, and the city is supplied with water from a reservoir free from troublesome organisms. Complaints of unpalatable water have been prevented by this procedure for many years.



Show the public your laboratory

However, when a community water supply is unpalatable, many complaints from consumers will be received. The procedure of explanation and reassurance should be carefully considered. The fact that the water is perfectly safe, if somewhat unpleasant, should be stressed. This explanation will prevent the possible use of other supplies, as wells or springs, the safety of which might be questionable. Public information that all department facilities are in operation to apply remedial measures will further reassure consumers. Criticism of the department will thereby be lessened, and public confidence in the water supply will not be impaired. The importance of understandable public statements in relation to a city-wide complaint is apparent. A favorable community response will be ob-



A view of the Cambridge, Mass., filter plant which the public is urged to visit

tained if the public is convinced that restoration of normal water quality will be speedily accomplished.

Changes in the chemical treatment of a water supply are sometimes observed by numbers of consumers who have detected the altered condition of tap water. In 1939 lime was substituted for soda ash in corrective treatment of Cambridge water. Hardness, alkalinity, and pH value were increased in the finished water. A few consumers communicated with the laboratory with reference to the increased hardness of the water. Industrial consumers, who analyze the tap water for process purposes, inquired about the changed conditions.

Explanations were issued that the object of the lime treatment was to minimize corrosion of pipes and fittings. The fact was emphasized that non-corrosive water would extend the period of service of house pipes. Analytical results showed that the water was comparatively soft, although the hardness had been increased by the new treatment. Public acceptance of the changed condition was readily accomplished, and no inquiries with reference to corrective treatment have been received for several years.

The second type of complaint is received from an individual consumer who reports unsatisfactory tap water. This represents an isolated instance, as contrasted with a city-wide complaint concerning the water supply. Individual complaints differ, of course, in the cause of dissatisfaction with the water. Inferior quality of drinking water would be of serious concern to a family in which there was sickness. On the other hand, everyone responsible for the quality of water in large communities can relate instances of "nuisance" complaints. These result from misunderstanding or misleading information on the part of the consumer. An effective public information policy will minimize the number of these complaints.

The suggested procedure for use with individual complaints consists of prompt investigation, analysis, and report. A consumer telephoned to the laboratory that her child was ill. The attending physician had suggested the possibility that the drinking water might have been responsible for the child's condition. The mother was greatly worried, and immediate action was requested.

Samples of tap water on the premises were collected. Examination indicated that the water was bacteriologically safe. Chemical analyses yielded normal results with all tests, closely approximating results obtained with plant samples. The examination proved that the water supply was not a possible source of infection, and the consumer was accordingly notified.

This example illustrates the type of complaint received from a worried individual who is seriously concerned about the quality of tap water on the premises. Plant records of analyses would have provided data indicating that water quality was satisfactory throughout the city at the time the trouble was reported. However, the prompt investigation by the water department not only reassured the consumer, but showed willingness to consider the case of this consumer as an individual.

Careful consideration should be given to complaints from individual consumers who report colored or dirty water at the tap. Red water troubles have been eliminated in Cambridge since the application of corrective treatment to the finished water. The occasional complaint of dirty water might be caused by repairs to mains which require opening and closing of gates. Heavy draft of water from a hydrant, with disturbance of water in connecting mains, will sometimes cause re-

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 63-65.

ports of colored water. Consumers are assured that this trouble will be of short duration, and thorough flushing of house piping is suggested. The program of main cleaning recently completed by this department will further decrease the infrequent occurrence of these complaints.

Another factor which warrants consideration with complaints of dirty water is the condition of the house piping. Many older houses are provided with water pipes of inferior quality. The extent of service of these pipes is limited, and if deterioration has started, the water quality will be adversely affected. It is good practice to observe the condition of the water pipes on premises from which a report of colored water has been received.

The investigation of individual complaints requires the use of tact by the department representative. Excellent opportunities to build good will are afforded by these incidents. The consumer will be fair about the matter if the department indicates willingness to give consideration to reasonable requests.

Considered in broader aspects, legitimate complaints from consumers are evidence that the public is becoming aware of rising standards of water quality. Consumers demand that the water supply be safe, and in addition water must be free from color, unpleasant odor and taste, excessive hardness, and corrosive powers. Objectionable elements as iron and manganese must be removed. Public insistence that the community water supply conform to these standards is reflected in the complaints received when water of inferior quality flows from household taps.

Relations With Industry

In recent years industry has given more attention to the quality of water used for commercial purposes. Rising standards of industrial products require scientific control of the water used in many manufacturing processes.

An industrial establishment, in which control of process water is necessary, often will communicate with the filtration plant to request information concerning the water supply. A detailed report of analysis might be desired; or an inquiry referring to a single determination, as the silica or sulfate content of the water, may be received. An engineer in charge of steam production will request the figures for hardness of the water. Temperature averages are useful to dealers in air-conditioning equipment.

When an industrial communication is received at the laboratory, an invitation to visit the plant should be extended to a representative of the company. This procedure permits inspection of the treatment applied to the water supply, and an opportunity is offered for discussion of the problems of process water with reference to the industry. Many industrial consumers in Cambridge have accepted invitations to inspect the plant, and excellent relations between the department and local industries have been developed.

There are other methods of creating public interest in the community water supply. The history of the local department from its small beginning, 100 years ago, to the present time, and the description of the filtration plant have been used in the preparation of a lecture entitled "Water Purification." The author has spoken on this subject before clubs, college groups, and hospital classes. The talk can be made technical, for instance, before a college chemistry class, and with an organization of laymen non-technical terms and illustrations are used.

Preparing Exhibits

Exhibits can be prepared which will illustrate details of laboratory procedures, such as bacteriological materials and tests and bottles of raw and filtered waters. Samples of chemicals used in water purification—alum, lime, soda ash—can be effectively exhibited to dispel doubt in lay minds about "doping" a water supply. The amount of alum in a test tube required for the treatment of a barrel of water, say 50 gallons, in proportion to the plant dosage in pounds per million gallons, will convince listeners that excessive chemical treatment of the water is not practiced. They can understand the figures quoted in this illustration, but the terms used in water purification practice are difficult for them to comprehend. The author has also prepared photographs of microscopic organisms and bacteria which are useful exhibits.[1] The answers to any questions that may be asked will serve to clarify details of the community water supply in the minds of the listeners. Organizations are invited to inspect the features of the local water supply. This inspection can be undertaken by the club as a group, or as individuals.

The question may arise concerning the need of good public relations with reference to the municipal water supply. This necessity of life must be used by all inhabitants of the community. No other supply is readily available. Is the effort to create good will necessary?

The fact that a community water supply is a valuable civic asset, so often overlooked in programs of community advertising, should be told to the public. It also should be a matter of public information that water supply exerts considerable influence in the selection of a city for the location of many industries in which water quality is important. The support of the public in securing municipal expenditures for improvement of the community water supply will be obtained more easily when a favorable attitude has been fostered by a dignified public relations policy.

Life exists at a too rapid tempo to permit much time for study by the public in many fields of municipal activities. Handicapped, due to public indifference toward the work and the isolated location of much of the physical plant, the community water supply is one of the casually accepted features of modern life. It will remain in this status until publicity is focused on the character of the work faithfully and economically performed.

The development of public interest in water supply activities is possible by means of resources controlled by the department. This task has been effectively accomplished in a dignified manner by some water departments. Public recognition will not be achieved by any department without the expenditure of time and effort. The development of good will and pleasant consumer relations constitutes a challenging program to water departments in the new decade just revealed by the calendar.

1. Water Works and Sewerage, June, 1939, p. 230.

Amount of Garbage Per Person

The American Public Works Association has collected data from 47 cities which show that the average weight of garbage collected in these cities is 234 pounds per capita per year, or a little more than one-half pound daily for each person. An analysis of the returns shows that the normal range is from 167 to 327 pounds per capita per year, and that this wide variation cannot be attributed to the geographical location or the size of city.

How Adequate Highway Lighting Reduces Traffic Accidents

THE American Automobile Association credits the National Bureau of Casualty and Surety Underwriters with a 60-city survey which shows the important relationship of adequate street lighting to public safety. Highlights of these findings, according to the Association, are:

1. "Superlighted" heavy traffic arteries with lighting intensities six or seven times the standard for city streets experienced a night fatality rate a trifle less than twice the day rate.
2. On similar streets, with "A" lighting intensities (close to standard), the ratio of the night fatality rate to the day fatality rate was eight to one. With less effective "B" lighting, the corresponding ratio was twelve to one; with "D" lighting twenty-three to one.
3. For all classes of streets and all grades of artificial lighting then in use, the ratio of the night fatality rate to the day fatality rate on streets studied was fifteen to one for pedestrians and eleven to one for the occupants of vehicles.

Perhaps the outstanding example of all is the traffic safety lighting program of Detroit, Michigan. Detroit's night-to-day fatality rate jumped from 1.76-to-1 in 1933 to 2.4-to-1 in 1936. As the old type "horse and buggy" lighting was changed over to traffic safety lighting in 1937 and 1938, the night-to-day fatality ratio for the city dropped from 2.4-to-1 to 1.68-to-1. This rate was expected to drop still further to 1.4-to-1 at the end of 1939. Night traffic fatalities on the streets safety lighted dropped from a ratio of 7-to-1 down to 1.5-to-1. Detroit accomplished these results by installing 300 miles of traffic safety lighting on the main arteries, and in addition installing 3,500 more lights throughout the city.

In one year, New Jersey's highway death toll at night was 91 less than the previous year in the sixteen counties where modern state highway illumination was installed. The records show that 154 persons died in state highway accidents after dark during 1938 as compared with 245 in 1937, a decrease of 37 per cent in night fatalities in the sixteen counties. This decrease in night deaths was made despite a marked increase in the volume of traffic during 1938, and although the new lighting systems were not erected until the latter half of the year in some sections. Fatalities in day accidents on the same sections of the State Highway System totaled 115 for 1938, in contrast to 128 in 1937, or only a 10 per cent decrease over 1937; 1939 data are not yet available. On Route 43, from Camden to Absecon, 10 pedestrians were killed in one year before safety lighting, compared with but one pedestrian killed in one year following safety lighting.

In Los Angeles, an outstanding job has been done in night accident reduction through safety lighting at important intersections. A report by the Los Angeles Street Traffic Engineering Bureau shows the following results for equal periods of time before and after the installation of sodium lighting at 25 intersections.

Accidents reduced	84 per cent
Injuries reduced	88 per cent
City property damage reduced	75 per cent
Fatalities reduced	100 per cent

Alhambra, California, reports a 75 per cent reduction in night accidents at 14 important intersections during the past four years, through sodium lighting.

Two years prior to installation of sodium lights on 3 miles of U. S. Route 91 outside Salt Lake City, 12 fatal night accidents and 57 night injury accidents occurred. Recent records reveal that fatal night accidents on this stretch have dropped from twelve to three, and night injury accidents have declined from 57 to 29 in two years following the installation of safety lights. This decrease is reported despite the fact that early night traffic on the lighted route has increased to over 1,500 cars per hour.

One of the most remarkable records of safety for a stretch of highway has been set by the San Francisco-Oakland Bay Bridge. Although cars have been using the bridge at the rate of nearly 25,000 a day for some three years, each traveling eight and one-quarter miles for the passage, there has been only one accident for every 1,000,000 car miles traveled. Good lighting on the bridge has held the night accident rate to 1.26 accidents for every day accident.

Despite numerous proofs that proper and adequate night lighting does have a favorable effect in decreasing night traffic death rates and accidents, there is a school of thought which would have the Federal Government illuminate two or three long stretches of accident-prone trunk highways and conduct studies with the aid of permanent lighting in various intensities. These studies would include not only the effect of lighting on night accidents, but also the effect of lighting to decrease nervous driver strain.

The unlighted 37-mile Baltimore-Washington highway, with its proximity to the national capital and because of its exceedingly abnormal night death and heavy traffic rates, would be a logical trunk route on which to conduct such experiments. In 1938, three quarters of all the people killed on this highway were killed at night. In other words, 24 out of 33 deaths occurred after dark. In considering the night fatality record, it must be remembered that only one-third to one-quarter of the traffic volume is moving after dark. Its heavy traffic rate is established by the fact that over 13,000,000 persons travel the highway every year. At certain periods, the traffic peak reaches 50,000 cars a day. The highway represents but .0075 per cent of all the State roads in Maryland.

These data are abstracted from a report of the Committee on Safe Highways of the American Road Builders' Association, presented at the 1940 convention. Bernard C. Hartung, Nevada State Highway Dept., is general chairman, and Michael A. Connor, Commissioner of Motor Vehicles, Hartford, Conn., is chairman of the subcommittee on Highway Illumination.

Wind Erosion Control In Texas

The projection of a highway through the grass lands destroys Nature's balance by disturbing the soil binder or cover, leaving naked cuts and fills where the wind can begin its destruction. An example of this wind erosion is a six-mile project completed late in December, 1938, which, on inspection in May, 1939, showed about 7,000 cu. yds. of soil had been blown away in 4 months. Cuts and fills were deeply eroded and the ditches were filled. *(Turn to page 38)*

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 63 to 65.

Continuing maintenance of highways subject to wind erosion being too expensive, the Texas Highway Department undertook some experiments with backsloping, mulching and seeding. The work described below was carried out during March and April, 1939, on U. S. 60 in Hemphill and Lipscomb counties.

The eroded and unstable cuts were backsloped to 4:1 or 3:1, depending upon the depth of the existing cut. This work was started from the top of the cut, blade graders being used to cast the excess material downward. This excess material was removed with a "tumblebug" and used to fill in low ditches and widen adjacent fills. After this rough grading, a heavy drag consisting of a 12 in. x 12 in. timber was used finishing the slopes.

The backsloping completed, a mulch of rye and wheat straw was placed by hand over all newly graded areas (cut slopes, ditches and fills) to a depth of about two inches. Next grass seed and skunkbrush seed was scattered over the mulch at the following rates:

Sand Drop Seed (Sporobolus Cryptanrus)	50 lb. per acre
Sand Reed Grass (Calamovilva Gigantea)	10 lb. per acre
Skunk Brush (Rhus Trilobata)	5 lb. per acre

With the seeding completed, the mulch was turned under, only enough dirt being turned over to hold the straw in place. After this operation, watering was continued from day to day until the work had been thoroughly wetted by a good rain.

Since completion of this work several windy days have tested it, and the job has stood up very well. In addition to a light stand of seed grass, wheat and rye seeds carried in with the mulch, and weed seeds which were blown in or were present in the dirt at the time of backsloping, have germinated. There seems to be little doubt that the described procedure of mulching for wind erosion control is practical.

This material is from Highway Research Abstracts. It was prepared by J. F. Vearling of the Texas Highway Department and published in the "Information Exchange."

Relief Labor and Modern Machinery Build High-Grade Roads

(Continued from page 13)

The loose stone is spread nearly the full width of the pavement and an application of .75 gallons of bituminous material per square yard is applied to the loose stone before mixing. The stone and bituminous material are then mixed-in-place by an Adams retread blade mixer. This machine moves forward and as it progresses it mixes the bituminous material with the stone and spreads same. With one and one-half round trips the stone and asphalt are thoroughly mixed and spread to the full width of the pavement, after which the stone and asphalt are partially compacted by rolling.

A second application of bituminous material of .45 gallon per square yard is then applied as a penetration application and a light application of No. 1 stone chips are spread in sufficient quantity to fill the voids; the road is then further compacted by rolling.

A seal coat of .4 gallon of bituminous material per square yard is applied and is immediately covered with No. 1 stone chips and thoroughly compacted by rolling. One three wheel 10-ton roller and one 10-ton tandem roller (increased to 14 tons by filling water

tanks) are used in compacting and completing the top course. Light oil is used on the rolls to the rollers to prevent adherence of the bituminous material.

Burch powered chip spreaders, attached to the dump trucks are used in applying the No. 1 stone chips. The No. 1 stone chips when applied and being rolled are thoroughly broomed, the brooms being attached to the rear of the rollers or drawn behind light trucks. Experience shows that the use of chip spreaders gives a smoother and more even spread and uses from 10% to 20% less stone than hand operations.

Using the Adams blade retread mixing machine, a gang working under good conditions, has laid as much as a mile and one-half of completed pavement sixteen feet in width in eight hours.

Equipment Used

No program such as the one described above could have been possible in Chenango County without the excellent equipment which the county has made available to carry on the road construction program. The equipment inventory of the Chenango County Highway Department includes: Forty-three trucks, varying in size from ¾-ton to 15-ton head the list. Of this number, 32 are Brockways, with load capacities from 3 tons to 15 tons, and eleven are small trucks (Chevrolet, Dodge and Ford) ¾ to 3-ton. Also five Linn tractors with dump bodies of 2 cubic yards capacity; one Caterpillar tractor and bulldozer; one Cletrac tractor and bulldozer; two International tractors and bulldozers; one Caterpillar tractor with an 8-yard 3-way dump, Athey trailer; one Cletrac tractor with 5-yard Athey trailer; one Bucyrus-Erie gas-air shovel, 1¼-yard capacity; two ¾-yd. Lorain diesel shovels; one 1-yd. Lorain diesel shovel; one ½-yd. Lorain gas shovel; one Universal truck crane with a ½-yd. clam bucket; three 10-ton, three-wheel Buffalo-Springfield rollers; one 10-ton Buffalo-Springfield tandem roller; one 10-ton Huber roller; one bituminous distributor, 1,000 gallon capacity; one Adams retread paver; one Schramm air compressor #315 mounted on truck; one Cleveland wagon drill; three Adams power graders; and two power Burch chip spreaders. Miscellaneous equipment includes pumps, air hammers for pile driving, concrete mixers, necessary small tools.

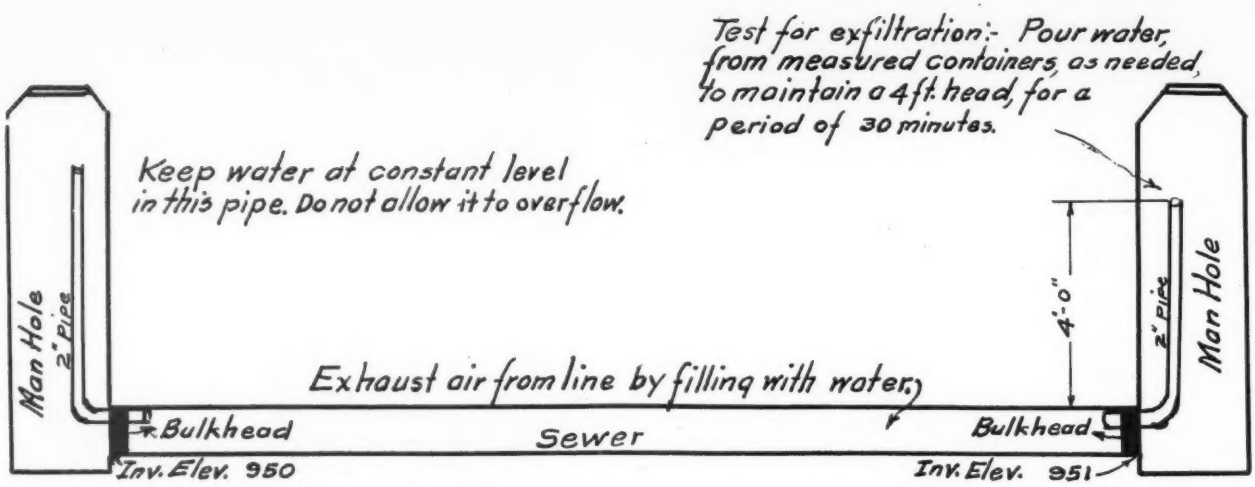
The county maintains a storage garage and a complete shop to service and repair all of its equipment.

Extendable Snow Fences

Snow fences that can be raised from an original height of 4 ft. to a total height of 9 ft. in 1-ft. movement are in use on a Nevada highway. The fence is mounted on 9-ft. steel posts placed on 12-ft. centers and braced against the wind pressure. Each post is constructed with hooks spaced to fit the stay wires so that the fence can be raised or lowered by 1-ft. intervals. The fence is first placed at the 4-ft. level and is raised as the snow depth increases. The fence itself is made of 1½ in. lath spaced 2 in. apart and linked with 12-ga. pliable stay wire.—Highway Research Abstracts from the Western Construction News.

Free Sand for Icy Sidewalks

Portland, Maine, supplies property owners with sand to spread upon their icy sidewalks, according to "Public Management." The sand is delivered by public works department trucks, upon the property owner's request, and no charge is made. In 1938 more than 2,200 orders of sand were distributed.



Sketch showing method used in Uniontown, Pa., for testing sewer line for exfiltration

Sewer Infiltration and Its Measurement—A Symposium

WITH the properly increasing tendency toward more and better sewage treatment, limiting the volume of sewage delivered for treatment becomes a matter of increasing importance. Excess flows increase first cost in treatment plant construction and impose a heavier continuing burden because of operation. In many, perhaps most, systems, excess flow is caused by infiltration of ground water. Too many sewers have been laid carelessly in the past. Slipshod workmanship and even inferior materials have been far too common.

Unfortunately, there is little a city can do to remedy these defects in existing sewers. Replacing sewers is very expensive. However, where most of the infiltration is confined to a few sections, replacing with tight sewers is often a worth-while economy. From a study of the flow in various lines, and at key points in the system, it is often possible to determine those sections where conditions are worst, and by correcting these, accomplish a marked reduction in flow.

In laying new sewers there can be no excuse for permitting such defects. Where they occur they usually are due to use of cheap sewer pipe materials; carrying on work under adverse conditions, as in an insufficiently dewatered trench; carelessly prepared trenches, permitting settlement of pipe sections with consequent breakage; and lack of adequate supervision of the making of joints. Whether vitrified clay, cast iron or other materials are used for the sewer, the pipe should conform to rigid specifications and be carefully inspected. Cheap pipe is no economy. Neither is use of cheap jointing material not capable of giving tight joints under the conditions encountered.

Supervision of house connections is another important factor, since these may sometimes contribute a much greater volume of infiltration than the sewers themselves.

Methods of testing new sewers to learn whether they meet infiltration specifications, and of locating sections of existing sewers where infiltration is excessive, are described in the following paragraphs by a number of engineers.

Method of Testing for Infiltration and Exfiltration in Sewer Lines

By WILBUR L. DUNN

City Engineer, Uniontown, Pa.

THE following methods were used for testing for infiltration and exfiltration in the new sewer system at Uniontown, Pa.

The ordinary method of constructing a weir with a 4" x 6" slot, with a water-tight bulkhead at the high end of the section to be tested, was used to test infiltration, measuring the flow for a designated period. In most sections tested, infiltration was found to be well under the limit of 10,000 gal. per mile, in 24 hours. In any system where the limit was exceeded, examination always showed a cracked pipe or defective joint, and repairs were made.

The Chester Engineers of Pittsburgh, Pa., who designed and constructed our sewers and disposal plant, with H. F. Lundberg as resident engineer, were not satisfied with a simple *infiltration* test and specified the following test for *exfiltration:*

On each section of sewer, between manholes, the ends of the sewer were plugged with water-tight bulkheads, and a 2" pipe, with elbow, inserted in each bulkhead, at the top of the sewer pipe, extending 4 feet up in the upper manhole and to the same level in the lower manhole.

The air in the sewer was exhausted by filling it with water to a height of 4 feet in the pipe in the upper manhole. Using measured containers, water was poured into the upper pipe as needed to maintain a constant head of 4 feet in the upper pipe, and a constant level in the lower pipe for a period of thirty minutes, not allowing the lower pipe to overflow. At the end of thirty minutes a record was made of the amount of water used, the distance between manholes measured, and the exfiltration per mile, per 24 hours was computed.

This seems to be a much more rigid test than the one used for infiltration, and shows leakage to a much

greater degree. On one section, infiltration as measured by a weir, showed 3,500 gal. per mile, while the exfiltration test showed almost 9,000 gal. per mile. Sewers that are large enough for men to go through, and lying in swampy ground, have been examined and found perfectly dry, and by the exfiltration test show from 25% to 50% of the allowable leakage of 10,000 gal. per mile per 24 hours.

On our sewers Weston gaskets were used on all joints and cement grout forced by means of pumps into the joint. Great care was taken to prevent any movement of the pipe after the joints were poured and until they were well set. In very wet ground, and in rock cuts, the pipes are laid on a cushion of stone chips. This probably helps take the water away from the sides of the pipe, acting as a drain; also the nature of the soil used for fill next to the pipe has something to do with the amount of infiltration. In exfiltration these factors do not enter, and any pipe that will come under the limit set by the test is sure to be 25% to 50% under the limit by the usual infiltration test.

Following are the records of a few tests:

Lin. ft.	*Exfiltration*	*Infiltration*
617 ft.	34½ gal.	0
815 ft.	31½ gal.	0
400 ft.	27 gal.	0
450 ft.	22 gal.	0
308 ft.	9 gal.	0
405 ft.	12 gal.	0

These data have been collected and compiled by H. F. Lundberg who has been on the job constantly and has conducted all the tests. The exfiltration test may be somewhat more difficult for contractors to meet, requiring more careful workmanship and supervision, but a much better job will be the result, and that is the aim of every engineer.

Measuring Flows in Cranford, N. J.

By T. J. McLAUGHLIN
Supervising Engineer

IN Cranford, infiltration is probably a more serious problem than in some other communities of its size because Cranford's discharge is into a joint sewer constructed and maintained jointly with eight other municipalities. This discharge is limited to the gallonage originally agreed upon with the other communities. Moreover, this community is charged a proportion of the total cost of maintenance of the joint line and disposal plant based upon its pecentage of the total gallonage introduced into the Joint Trunk line. Constant measurement of this discharge is taken by the use of float wells and venturi meters. These measuring stations are set at strategic points so that the gallonage introduced by each community can be measured.

The method used to measure the infiltration in new lines in Cranford was designed mainly as a check against the construction methods used in constructing the sewer. A maximum infiltration is allowed per mile. These maximums are as follows:

8" vitrified pipe sewer—5,000 gals. per mile per 24 hours
10" vitrified pipe sewer—5,000 gals. per mile per 24 hours
12" vitrified pipe sewer—6,400 gals. per mile per 24 hours
15" vitrified pipe sewer—7,200 gals. per mile per 24 hours

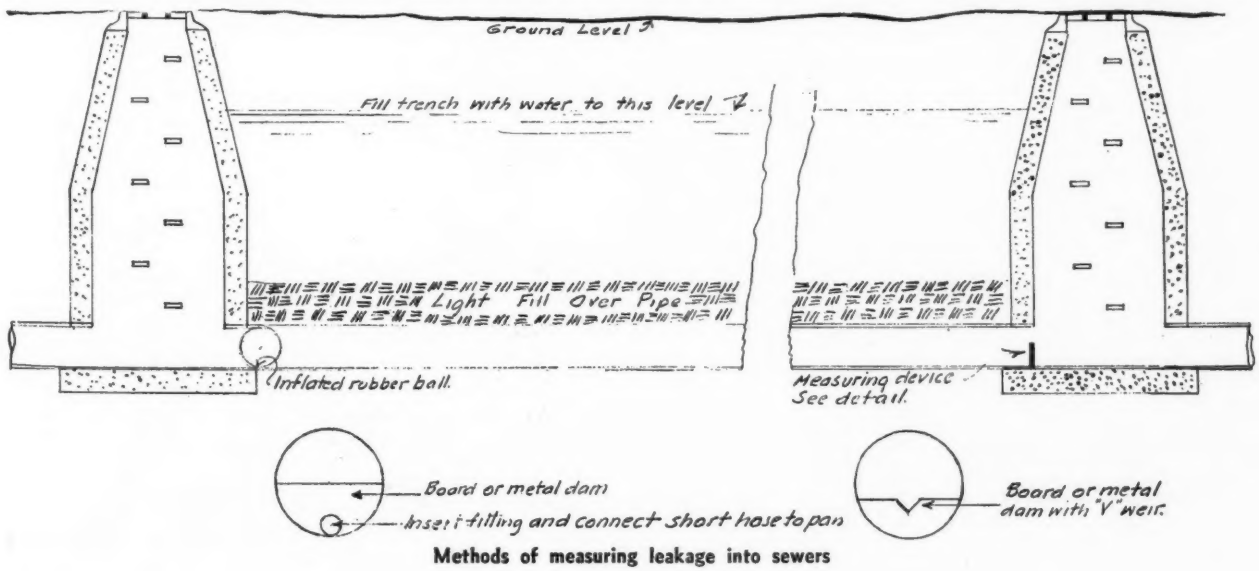
Measurements have shown that the methods used during construction have reduced the infiltration far below these maximums.

In arriving at the method to be used for measuring infiltration, thought was given to devising a simple and practical method. It was thought that the method of building up a head in a section and measuring the loss of water did not give a true picture because many of our sewers are in very wet soil. This condition might tend to show no loss while actually there would be considerable infiltration when the pressure in the pipe was reduced.

The method adopted and now in use is as follows: The trench is backfilled to within 12" of the top. The trench is then flooded in a manner so that the entire trench and adjacent sides are thoroughly immersed. Water is added until saturation is reached and at least 6" of water remains over a period of 24 hours on top of backfill. Maintaining full immersion is not difficult in Cranford because ground water is usually encountered at three to four-foot levels.

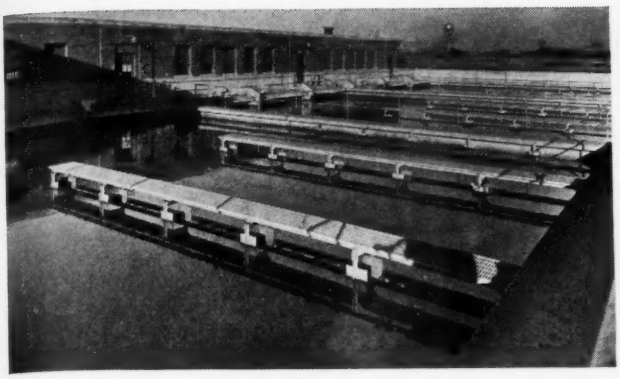
When it is apparent that the trench and surrounding soil is sufficiently saturated, a plug is inserted at the outlet end of the sewer. This plug must be water tight and completely block the pipe so that no leakage can take place. In the center of this plug a 1½" pipe is inserted. The outlet end of the pipe is connected to a receptacle. This receptacle is removed at certain periods, usually every hour, and a record made of the amount of water measured together with the time elapsed to accumulate this amount of water.

A certain latitude is allowed the contractor in the design of the plug. The design found most practical, is a solid piece of wood 3" thick cut to the exact shape of the bell with a rubber gasket inserted between the



Methods of measuring leakage into sewers

Activated Sludge Plant



24 STRAIGHTLINE Collectors for Concentration Tanks

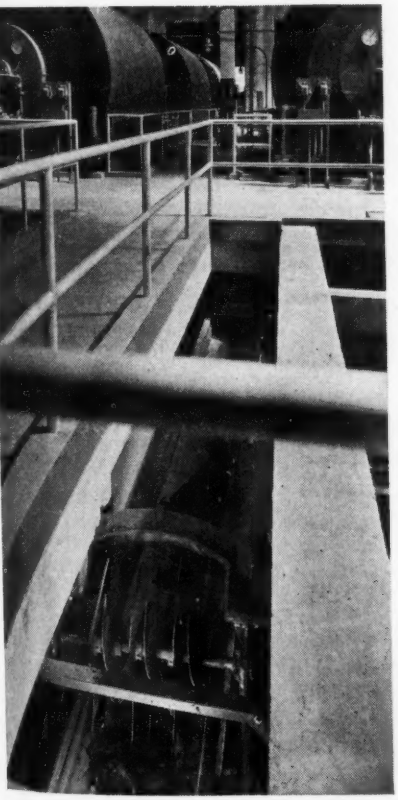
All waste activated sludge and preliminary sludge, including the waste sludge from the North Side Treatment Works, is delivered into these concentration tanks. Moisture content is reduced by settling for an average of 4 hours. There are six of these concentration tanks, each 46'9" wide x 70'0" long x 14'6" deep, all tanks being equipped with Link-Belt STRAIGHTLINE Sludge Collectors.

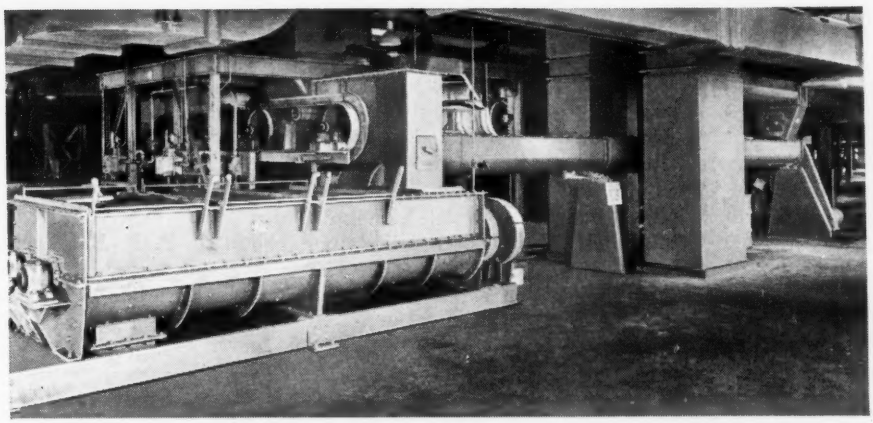
Before delivery to these concentration tanks, the sludge passes through three Link-Belt mechanically-cleaned bar screens with ½" openings.

Belt and Screw Conveyors for Filter Cake

In the sludge disposal building, eight Link-Belt screw conveyors and eight belt conveyors deliver wet filter cake and dried sludge to eight Link-Belt pug type mixers (at right).

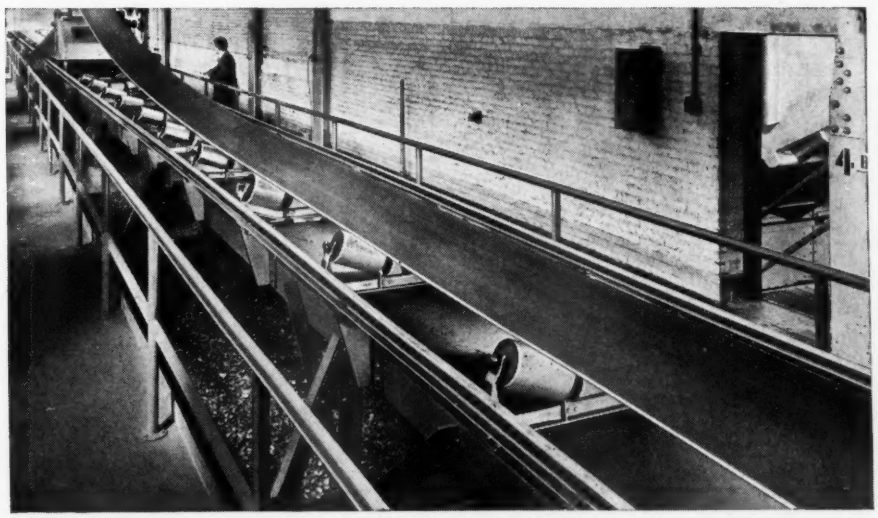
One of the belt conveyors which handles wet filter cake from the filters to sludge mixers is shown below. Enroute on the belt conveyor the sludge is distributed by revolving knives. Each belt conveyor serves three filters.





COAL HANDLING EQUIPMENT

Steam for plant operation is generated by four water tube boilers at the rate of 440,000 lbs. per hour. These boilers are designed to burn pulverized coal, or a combination of 60% dried pulverized sludge, mixed with 40% coal. Link-Belt coal handling equipment includes a double track hopper, twin reciprocating feeders, an apron conveyor, twin bucket elevators, and a 350-ft. long anti-friction belt conveyor (with automatic tripper) which distributes the coal across a gallery to eight storage bunkers.



LINK-BELT

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 63-65.

wood and the pipe bell. The 1½" pipe is usually forced into the block in such a manner as to make it water tight. Joint material is often poured around this pipe to insure tightness.

Sections of the sewer are sometimes tested where it is apparent that a certain section is infiltrating more than other sections. In such cases, the same procedure as described is followed with the addition of a solid water-tight plug in the upstream manhole, thus isolating this section from the rest of the construction.

Proper construction methods and careful inspection during construction are most important in reducing infiltration. The infiltration tests serve as a check against the value of construction methods and inspection.

Specifications on Leakage Tests

By HARROLD E. NORRIS

City Civil Engineer, Peru, Indiana

THE following specifications have been adopted for use in Peru, Indiana:

Leakage test.—All joints in sewer work shall be of such type and workmanship shall be of such quality that there will be no appreciable irregularities on the interior of the sewer after the work has been completed, and that there will be no perceptible leaking from any single pipe joint. The total seepage and infiltration of ground water, as determined by test, shall in no case exceed a rate of one thousand (1,000) gallons per inch diameter for twenty-four (24) hours per mile of sewer.

The Contractor shall furnish all equipment, labor and materials necessary for conducting leakage tests. The cost shall be included in the Contractor's bid price per lineal foot of sewer in place, and no extra payment will be allowed for conducting leakage tests.

The method of measuring the quantity of infiltration is done by one of two methods. The first, by measuring the amount of water pumped from the sewer over a definite period of time. The other, by measuring the depth of water over a twelve (12) inch width weir. Said weir is cut from a circular shaped piece of wood, shaped to the invert of the tile and having sufficient height so as to intercept all of the flow. The method for determining the quantity of water is from a table which reads as follows: (This table gives gallons per minute for various depths over the weir, from ⅛" to 2", or 1.48 gpm to 98.5 gpm).

Testing Procedure in Irvington, N. J.

By I. J. CASEY, Jr.

Town Engineer

Our procedure is simple. We test new sewers by two methods, depending on the soil conditions prevailing. In dry trenches, we test by puddling the backfill and watch for infiltration. If there is any, it is located and eliminated before the sewer is accepted. Where water is encountered in trenches, manholes are plugged and the sewer filled with water. By pre-measuring the manholes, we are able to calculate the rate of leakage, if any.

Other Data on Methods

P. L. Brockway, city engineer of Wichita; Kansas, says: "Most of our sewers are above the ground water line. The last one that was laid below ground water had quite a strict leakage specification. We expected to use what might be called a ponding method, because its

outlet was into a drop manhole which could be pumped out and the rate of filling thereby easily determined. Actually the leakage was so small that we had to measure it in a 3-gallon bucket and the rate was less than 10% of the specified maximum leakage."

L. M. Butler, city engineer of Clearwater, Fla., reports that they are now completing about 25 miles of sanitary sewers, varying in size from 6 to 24 inches. Infiltration tests set up for these lines require that the leakage be not more than 3 gallons per foot per day between any two manholes.

A number of interesting methods were reported, without explanatory details, by city engineers. Among them were:

Flow Over a Weir: Frank M. Charlesworth, City Engineer, Kaukauna, Wis.; E. R. Dike, City Engineer, Jackson, Tenn.; C. W. Mengel, Director Pub. Wks. & Service, Greensboro, N. C.; Stephen E. Preble, Village Engineer, Orchard Park, N. Y. (V-notch with hook gauge); John L. Miller, Boro Engineer, Roselle, N. J.; Geo. E. Gieseke, City Engineer, Gloucester City, N. J.; Thos. E. Purcell, Supt. Dept. of Pub. Wks., Bergenfield, N. J.; Chas. W. Darling, City Engineer, Grand Rapids, Mich.; L. R. Slocum, Engineer, Cambridge, Md.

Use of Dye or Blueing: H. M. Stanley, City Engineer, Clifton Forge, Va.; Chas. P. Clarke, City Engineer, Greenville, Pa.; Carl G. Pfeiffer, Com'r of Pub. Wks., Peekskill, N. Y.

Flooding Trench and Measuring Leakage: Stanley F. Moyer, Boro Eng'r, Souderton, Pa.; Chas. B. Hausser, Boro Eng'r, Madison, N. J.; B. F. Walter, City Engineer, Bonne Terre, Mo.

Filling Sewer and Measuring Loss: Francis McGrath, Village Eng'r, Port Chester, N. Y.; Geo. W. Gardner, Village Eng'r, Lowville, N. Y.; M. Fourmy, City Eng'r, Hammond, La.; E. J. Allison, City Eng'r, Hays, Kans.

Volumetric Measurement: W. H. Carper, City Eng'r, Fredericksburg, Va., H. J. Baum, City Engineer, Altoona, Pa.; Thos. F. McGilvray, City Eng'r, Duluth, Minn.

Other Methods: Examination using lights, L. M. Dow, City Engineer, Knoxville, Tenn. Test one section at a time, using a rubber balloon, F. R. Sheaffer, Boro Eng'r, Munhall, Pa. Actual pumping, C. T. Wilson, City Eng'r, Waterloo, Kans. Pumping from a measured sump for 24 hrs., Howard R. Green & Co., Consulting Eng'rs, Cedar Rapids, Ia.

Making Garbage Pay Its Way

Lakeland, Florida (18,554), one of a number of cities in that state which have recently established hog farms, is making a profit of $1,200 a month on the operation of the farm. Four Florida cities now levy a charge for garbage collection: Miami, $4.00 a year; Miami Shores, $10; Coral Gables, $12; and Fort Lauderdale levies a rate based upon the weight of garbage collected and expects to collect $19,000 a year.—"Public Management."

Glass Curbs for Safer Night Driving

For safer night driving a test installation of 15-miles of glass curbs has been made on English highways. Made of white vitrolite, a durable and opaque glass with exceptional reflective qualities, boundaries stand out more clearly.

Cost of Operating Rural-Mail-Carrier Motor Vehicles

THE report Cost of Operating Rural-Mail-Carrier Motor Vehicles on Pavement, Gravel, and Earth, by R. A. Moyer and Robley Winfrey, has recently been published as Bulletin 143 of the Iowa Engineering Experiment Station. In this report are analyzed cost records of 293 motor vehicles as follows: 248 automobiles operated by rural mail carriers in Iowa, 43 in Indiana, and 2 in Alabama, covering 170 routes.

Operation covered the period from November, 1935, to January, 1937. The report is based upon the original cost records kept by the individual carriers. These detailed daily records covered such phases of operation as miles of travel on each type of road surface, rates of travel, weather, number of stops, load, amounts of gasoline and oil used, and expenses incurred for tires, maintenance, garage, license, taxes, insurance, depreciation, interest, and extra help.

Records submitted were analyzed to determine the average total cost of operation on pavement, untreated gravel, and earth roads for a complete year and for the four seasons. The results obtained apply directly only to cars operating under conditions similar to those encountered by rural mail carriers.

The specific results are summarized by "Public Roads" as follows:

1. The average operating cost for cars traveling almost exclusively on pavement and gravel was 3.8 cents per vehicle-mile and 7.8 cents per mile for cars traveling almost exclusively on earth.

2. Extra help in delivering the mail cost an average of 0.2 cent per vehicle-mile on pavement and gravel and 1.0 cent per mile on earth.

3. The cost of replacing cars with men on foot or horseback, when the roads were impassable to cars, averaged approximately 11 cents per mile as compared to an average cost of less than 5 cents per mile with the cars when the roads were passable.

4. The graphical solution indicated an average annual mileage of 20,000 miles for cars operated exclusively on pavement and gravel, and 4,000 miles for cars operated exclusively on earth.

5. The average rate of travel (including stops) on the route during the year was about 13 miles in an hour on pavement and gravel, and about 9 miles in an hour on earth. During the summer the approximate average rate on pavement and gravel was 14½ miles in an hour and on earth 10½ miles in an hour, while these rates were respectively 11½ and 7½ miles in an hour during the winter.

6. The cost of gasoline, oil, and maintenance increased from about 2 cents per mile for cars with life mileages under 10,000 miles to 3 cents per mile for cars with mileages of about 50,000 miles. A similar trend was indicated for these costs when the age of the car increased from 1 to 6 years, but there was no appreciable change for cars more than 6 years old.

Results by the statistical method of least squares are:

7. The average cost of gasoline, oil, tires, and maintenance for the year was 1.56 cents per vehicle-mile on pavement, 2.59 on gravel, and 3.14 on earth.

8. The average gasoline mileage obtained was 15.02 miles per gallon on pavement, 13.04 on gravel, and 13.52 on earth.

9. The oil mileage averaged 264 miles per quart on pavement, 159 on gravel, and 113 on earth.

10. During the winter season the cost of gasoline averaged 1.50 cents per mile on pavement, 1.54 on gravel, and 1.58 on earth, while during the summer these unit costs were 1.21 cents on pavement, 1.24 on gravel, and 1.13 on earth.

11. During the winter season the cost of maintenance averaged 0.28 cent per mile on pavement, 0.77 on gravel, and 1.70 on earth, while during the summer season these unit costs were 0.05 cent on pavement, 0.38 on gravel, and 0.63 on earth.

Other results may be summarized as follows:

12. The average factory list weight of the mail-carrier cars was 2,680 pounds and the empty weight was 2,950 pounds as compared to an empty weight of 3,150 pounds for the average Iowa car. The average weight of the mail carried was 135 pounds.

13. The number of boxes per mile of route averaged 4 on pavement and gravel and 3¼ on earth.

14. The total average annual cost of operating the rural-mail-delivery cars, based on an annual mileage of 15,000 miles, was $500.26 on pavement, $627.76 on gravel, and $680.26 on earth, or 3.34 cents per mile on pavement, 4.19 on gravel, and 4.54 on earth.

15. A traffic volume of 63 vehicles per day will justify an annual interest charge of 4 per cent on an investment of $1,000 per mile and an increased maintenance expenditure of $40 per year per mile for improving a county trunk earth road with a gravel surface, based on the 0.35-cent-per-mile difference in motor-vehicle operating cost. If an additional charge is made to amortize this investment over a period of 10 years, a traffic volume of 128 vehicles per day will justify the change.

16. A traffic volume of 25 vehicles per day will justify the improvement from earth to gravel if travel time is evaluated as it was for the cars in this study and if the amortization of the investment is included.

17. An expenditure of 0.5 cent per vehicle-mile is justified for snow and ice removal from pavement during the three winter months when the difference in operating cost alone is considered, and 1.22 cents per vehicle-mile is justified when the time factor valued at 40 cents an hour is included.

Re-Use of Steel Water Mains of the Hetch Hetchy Supply

By CHARLES W. GEIGER

In 1931-'32 the Corral Hollow pipe line was constructed as a by-pass of the uncompleted section of the Coast Range tunnel of the Hetch Hetchy aquaduct; an emergency construction prompted by the dangerously low stage of water in the peninsula reservoirs after a series of unprecedently dry winters. It was proposed to pump water through them from an intake above the uncompleted tunnel, but a favorably wet winter replenished the reservoirs, and the pumps were not installed and the pipe line never used.

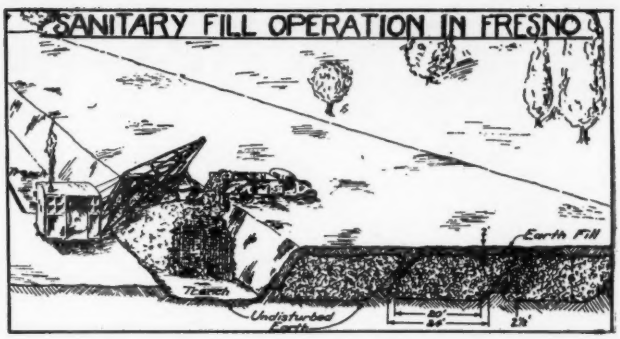
This line consisted of 24 miles of 36", 40" and 44" welded steel pipe. As there was no immediate use for pipe of this size, it was not salvaged. Recently, however, about 5.4 miles of 36" pipe was laid from the Hetch Hetchy supply line to Palo Alto, and part of this unused pipe was recovered and used for this purpose. In removing the pipe, the earth over it was excavated by blading with a bulldozer down to about 2" above the pipe. Then, using a wheel-type trenching machine, a trench was excavated 22" wide about 2" away from the side of the pipe. The pipe was then uncovered at intervals, generally of 60 ft., and cut with oxy-acetylene torches, and the freed length loosened from the ground by rolling into the side trench, then lifted to the surface.

The removed sections were cut into 30 ft. lengths and hauled to a plant of the Western Pipe & Steel Co. to be reconditioned. Here the old dip coating was burned off and the pipe thoroughly cleaned by shot-blasting. Each section was then carefully inspected to locate any pitting, and all pits over 1/16" deep were spot welded. A coal tar enamel lining was then spun on the pipe, previously heated to 400° F., and a coating of the same material was applied and covered with an unbonded wrapping of asbestos felt.

How Refuse Disposal Is Accomplished by Sanitary Fill

Experiences with refuse disposal by the sanitary fill method in Fresno, Calif., were described by Jean L. Vincenz, Commissioner of Public Works at the annual meeting of the American Public Works Ass'n. This practice was begun in Fresno in October 1934. During the past year about 24,000 tons of mixed garbage were disposed of at the fill at a cost of 24c per ton, including all operating costs, depreciation of equipment, and a complete write-off of the land cost of the fill site.

The accompanying diagram indicates the method of making the fill. A shallow trench, about three to four feet in depth and twenty feet in width, is dug into which the mixed garbage is dumped to a depth of about eight feet. The fill material is then covered with a twenty-four inch compacted earth cover obtained by digging a second trench parallel and adjacent to the face of the fill. Throughout his remarks on this disposal method, Mr. Vincenz emphasized the sanitary aspect and explained that it is essential to cover thoroughly the side slope with earth as well as the top of the fill. Strict control is maintained at the sanitary fill to protect against rodents, and no one has even seen a rat at the fill. Use of an earth covering of sufficient quantity and depth is the best rodent protective measure according to the state sanitary inspectors, as experience has shown that rats will practically never burrow through as much as twelve inches of earth.



Method of covering garbage used in Fresno, Calif.

Temperature tests have been made over the five-year period the fill has been operated. After sealing, the temperature within the fill increases, within a thirty-day period, to a point about 20° higher than that of the surrounding soil. The temperature curve then drops and rapidly flattens out, approaching the temperature of the surrounding soil after about ten months. That complete decomposition of garbage has been accomplished in that period of time is further borne out by studies which show that all settlement has occurred during the same period.

The Sewerage Digest

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published

Rate of Development Of a Trickling Filter

Study of the time required for the growth of biologic life in trickling filter medium was made on a 0.22 acre trickling filter receiving sewage entirely domestic in character, during April-July at Albany, N. Y. During the first 28 days, although there was a gradual decrease in the oxygen consumed and B.O.D., indicative of oxidation of the organic material, the values fluctuated widely, due probably to variations in the concentrations of the raw sewage. The trend continued at a reduced rate for 60 days; and thereafter the B.O.D. remained practically constant at about 20 ppm and the oxygen consumed at about 35 ppm.

For 20 days after the filter was placed in operation only typical sewage organisms were found in the bacterial slime. Then species less tolerant of heavy pollution began to appear; and between the 40th and 50th days the variety of organisms increased, including some tolerant of only a small amount of putrescible matter; and after the 50th day organisms whose normal environment is clean water began to appear. The temperature of the sewage ranged from 10° to 23° C. In warmer weather these periods might be considerably shorter. Also the rate of application was only 25% of the standard rate, and this probably had some effect on the data recorded.[C22]

Treatment of Cannery Wastes

From a chemical point of view, the main problem in treating vegetable waste is one of breaking down by oxidation the high content of sugars and starch to water and carbon dioxide, and screening out the cellulose. The vegetable acids as well as the fruit acids can easily be neutralized. Corn is by far the worst waste encountered; it does not readily respond to chemical treatment or to plain sedimentation, the carbohydrates are present in the form of starch, the suspended matter is held in colloidal suspension, and the B.O.D. extends over a long period of time. Pea canning waste is highly putrescible and the carbohydrates are present for the most part in the form of quickly reducible sugars. Tomato waste is a problem because of the heavy tonnage packed and the large volume of water used; it contains a high percentage of suspended matter which can be screened out before treatment. But waste is troublesome because of the tops, tails, skins and color of the waste. Berries and fruits, except apples are not troublesome, nor difficult to treat. Ensilage waste from pea vines, corn husks or cobs, or lima beans should never be taken into a sewage treatment plant under any circumstances.

General conclusions are that: Canning wastes, if not excessive in volume should be treated in existing sewage treatment plants, but preliminary treatment by the industry is essential in most cases. It is not economical to employ a screen at a sewage treatment plant with less than 16-mesh, 8-mesh is preferable. Activated sludge plants are not suitable for handling cannery wastes, as bulking is increased due to the increase in Sphaerotilus growth from increase in carbohydrate content in the waste-sewage mixture. Removal of all possible solids within the canning plant as garbage rather than as liquid waste reduces the load on the treatment plant.[C26]

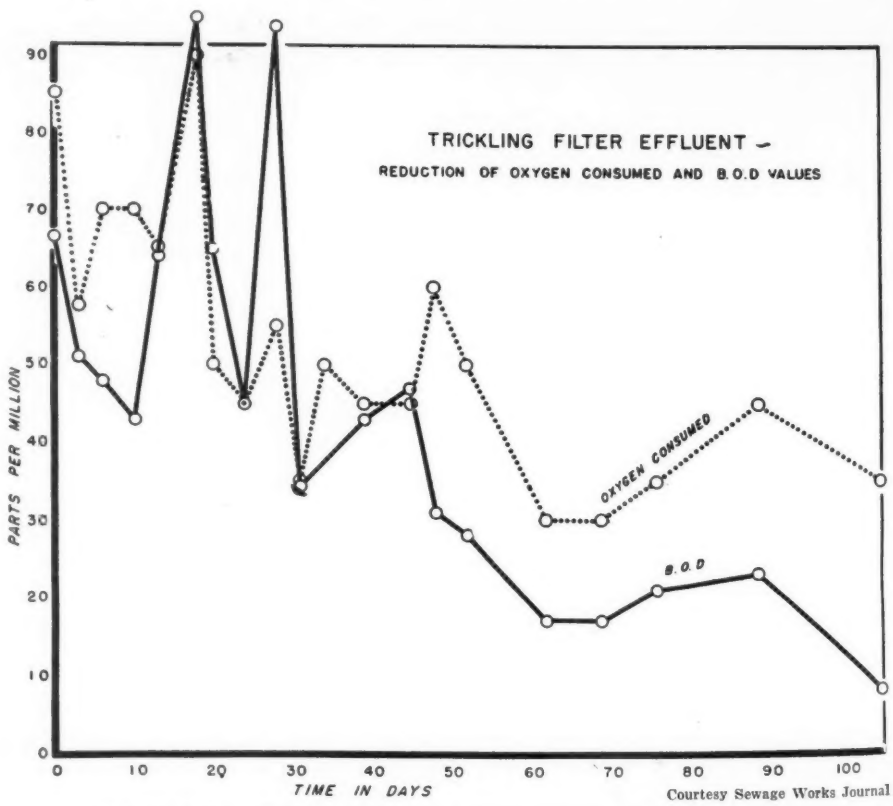
Treatment Plants Constructed in 1939

At the beginning of 1939 there were approximately 4,700 sewage treatment plants in service in the United States, but over 1,700 of these were merely old septic tanks, screens or land treatment. During 1939, 848 new plants were built or in the building, to serve nearly 12 million persons, and costing about $101,000,000. Of these 848 plants, 222 were for towns of 1,000 population and under, and 727 were for cities under 10,000.

A large percentage of the plants include separate sludge digestion. Activated sludge process made further progress in both large and small cities. Trickling filters were installed in more than 300 plants, 27 of them being "high rate" filters.[H12]

Flow of Sludge Through Pipes

When sludge is stored it stratifies and the bottom concentrates to a jelly-like character which does not flow readily; if solids concentration exceeds 8%



Courtesy Sewage Works Journal

Trickling filter effluent. Reduction of oxygen consumed and B.O.D. values.

Drawn by Dean Cornwell. Copyright 1940, U. S. Pipe & Foundry Co.

NEARLY everybody knows that cast iron underground mains give the best service for the longest period of time. "Best" service means trouble-free service. Long life, in the case of cast iron pipe, means a *century or more.* The result is lowest cost per service year. We manufacture Super-de Lavaud chill-free, centrifugally cast pipe and U. S. pit cast pipe. We have on hand for immediate delivery large stocks of pipe and standard fittings in plant and storage yards throughout the country.

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it can not be pumped efficiently through 24" pipe unless thoroughly mixed with water. Two years' experience pumping through 440 ft. of 24" pipe, with solids concentration varying from 5.2 to 8.4%, temperatures from 48° to 73.5° F., and ash content from 21.4% to 40.1% of the dry solids, required pumping heads varying from 14 to 42 feet. The head increased with increased solids concentration, but still more with decreased temperature, the greatest temperature effect being below 65°F. The temperature effect varied with the season, possibly due to bacterial action in warm weather causing partial liquefaction of the sludge. The ash content of the sludge effects its gel-like structure and hence its viscosity, rate of flow increasing with ash content.[C21]

A Sewage Screenings Problem Solved

Hand cleaned screens and the nuisance and difficulty of disposal of screenings by burial have been solved in Bloomington, Ill., by the installation of a Rex Triturator and automatic screen. The triturator costs 3.8 cents per day to run, and the screen 2.8 cents, representing a considerable saving over the old method of hand work.[G8]

Some Results at Richmond-Sunset Plant

This plant (described in PUBLIC WORKS, Vol. 70, No. 9, Sept. 1939) was started operating by stages during March-May, 1939. Each unit was studied to learn the operating methods that would produce maximum efficiency. The grease was floated by use of air diffusion, and moved to the outlet by water sprays; which worked satisfactorily except that at times it is necessary to supplement the water sprays by hand raking. Mechanical flocculation gave best results with paddle speed of 0.8 fps at the periphery. Sludge is removed by flight conveyors, and thicker sludge is obtained by operating them intermittently, one hr. on and one hr. off, than continuously. For prechlorination to prevent odors it was found necessary to use at least 3 lb. per mg; for post-chlorination, chlorine has been fed at 60 lb. per mg from 8 A. M. to midnight, and then 30 lb. to 8 A. M., but this does not always give a plant residual. In elutriating the sludge, two washings of approximately 3:1 wash water and mixing just to the point where a heavy floc occurred gave results using less than 2% ferric chloride; if agitation was prolonged the floc was broken up. Best results are obtained by adding the ferric chloride to the sludge as it enters the inlet pipe to the vacuum filter without any stirring.[C23]

Removal of Glucose By Activated Sludge

Investigation of rates of removal of glucose from substrates by activated sludge show that such removal is effected much more rapidly by activated sludge than by domestic sewage, pure cultures of B. Coli, B. aerogenes, Sphaerotilus natans, or zoogleal sludge. The removal rate roughly doubled for each 10° C. increase in aeration temperature from 0° to 35°; but temperatures over 45° C. were inimical to glucose removal by activated sludge. When activated sludge was aerated below a pH of about 6.0 the rate of glucose removal was reduced and at 3.9 it practically stopped. Apparently there was little if any reduction in removal rate as the pH was increased from 7.0 to 9.6. Starvation of the sludge by reaeration without adding food steadily reduced the glucose removal rate. If chlorine was added to a mixed liquor containing about 1500 ppm of sus-

pended sludge solids at doses of 1.6 ppm, the glucose removal reaction was only slightly affected; but if the dose was 6.2 ppm the removal rate was reduced 75%, and with 15.0 ppm of chlorine the removal reaction was completely stopped for 4 hours.

"The results of this study, using glucose as a representative of the large fraction of the organic material present in true solution in sewage, indicate the probability of the very rapid removal of such constituents from sewage by the purely biochemical processes in activated sludge and demonstrate the sensitivity of such processes to temperature, proper pH, balanced nutrients, starvation, chlorination, acclimatization, and oxygen depletion. Under the maintenance of proper conditions, such constituents can be removed at rates which compare favorably with the removal of material in suspension from sewage by activated sludge."[C20]

Effect of Diet on Nitrifying Ability of Sludges

Testing from different activated sludges fed with five different sewages, variation in nitrifying ability of the sludges fed on different diets could not be correlated with either B.O.D., ammonia nitrogen or organic nitrogen of the food materials considered individually. The ratio of B.O.D. to ammonia nitrogen in the different diets varied from 8.2 to 21.0. Sludges fed on the former developed the greatest ability to oxidize nitrogen, while sludges fed on diets containing 16 or more ppm of B.O.D. per unit of ammonia nitrogen lost most of their ability to oxidize nitrogen; and this ability varied more or less uniformly between these limits.[C18]

Sewering Darien, Conn.

Darien is completing a sewerage system and treatment plant for 6,000 population costing $565,000. Two pumping plants are required to bring all the sewage from 3 drainage areas to one outlet, and a third at the treatment plant. Treatment consists of comminution, sedimentation, chlorination, and discharge into Long Island Sound 1500 ft. beyond low water line; with sludge digestion and drying on glass-covered beds. Among the unusual features are a force main of 10" Transite pipe 3,300 ft. long with 58 ft. rise, and another of 12" Universal pipe 2,000 ft. long with 55 ft. rise. Provisions for cleaning the force mains consist of a T on the outlet from the pump, on which is bolted a blank flange tapped for a 2½" hose connection, through which a fire engine can pump water for flushing out the main. At the outlet, the force main terminates in a flanged casting to which can be bolted a flange provided with a hose connection, a pipe-cleaning machine ("go devil") having first been inserted in the main, and then forced through by the fire engine pumping from this end.

Where the streets are paved with concrete, a sewer is laid on each side of the street. A sewer is carried across a deep railroad cut by suspending 80 ft. of bituminastic-lined 8" steel pipe from the girder of a highway bridge.[H13]

Growth of Refuse Incineration

During the year 1939, 30 incinerators were built, completed or contracted for in 12 states. Their capacities ranged from 12 tons to 600 tons, totaling 3,175 tons. Eight plants were under 50 tons; thirteen were 50 to 100 tons; five were 100 to 200 tons; and four were over 200 tons.[H11]

Los Angeles Plans More Sewers

Rapid population increases have overloaded many Los Angeles sewers and a comprehensive plan has been worked out calling for a total expenditure of $32,000,000, of which $17,580,000 is for immediate work. Of this, about $13,000,000 is for sewage treatment. Average daily flow of sewage is 82 gals. per cap., and peak flows are as high as 205 gallons.[E10]

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n,* note or short article; *p,* paper before a society (complete or abstract); *t,* technical article.

C *Sewage Works Journal*
January

18. t. Influence of Nutrition in Determining Activated Sludge Characteristics. By C. N. Sawyer. Pp. 3-17.
19. t. Growth-Promoting Substances in Sewage and Sludge: Detection by Biological Agents. By W. Rudolfs and B. Heinemann. Pp. 18-26.
20. t. Removal of Glucose From Substrates by Activated Sludge. By C. C. Ruchhoft, J. F. Kachman and W. A. Moore. Pp. 27-59.
21. Properties of Sludge Which Affect Its Discharge Through 24-Inch Pipe. By W. Rudolfs and L. E. West. Pp. 60-72.
22. Development of Sewage Oxidation by A Trickling Filter. By F. W. Gilcreas and W. W. Sanderson. Pp. 73-80.
23. The Richmond-Sunset Sewage Treatment Plant. By B. Benas. Pp. 81-94.
24. Laboratory Control of the Operation of the Richmond-Sunset Plant. By K. Fraschina. Pp. 94-96.
25. Maintenance and Operation of the Richmond-Sunset Plant. By R. R. Sotter. Pp. 96-98.
26. Effect of Cannery Wastes on Operation of Sewage Treatment Plants. By W. A. Ryan. Pp. 99-107.
27. Operations of an Activated Sludge Treatment Plant for Disposal of Dairy Wastes at the H. W. Walker Co. By S. D. Montagna. Pp. 108-113.
28. Pollution of California State Waters from the Viewpoint of Sports Enthusiasts. By H. Vernon. Pp. 114-117.
29. Pollution of Navigable Waters or Interstate Streams from the Standpoint of the Federal Government or Army Engineers. By E. C. Kelton. Pp. 118-127.
30. Safe Handling of Gas at Sewage Plants. By L. L. Langford. Pp. 128-132.
31. Utilization of Sludge Gas for Power Production. By J. F. Hecking. Pp. 132-143.
32. Maintenance of Sewage Treatment Plant. By H. J. Krum. Pp. 143-147.
33. Safety in Sewage Disposal Plants. By N. W. Hartz. Pp. 147-151.
34. Sewer Maintenance. By H. J. Huber. Pp. 152-160.
35. A Sampler for Dissolved Oxygen Tests. By A. A. Hirsch. Pp. 160-162.

E *Engineering News-Record*
February 15

9. Sanitary Engineering: Review of 1939. By E. J. Cleary. Pp. 65-66.

February 29

10. Los Angeles Plans to Spend $32,000,000 for Handling Sewage. Pp. 45-46.

G *Water Works & Sewerage*
February
9. Disposal of Sewage and Industrial Wastes Developments and Trends in 1939. By F. W. Mohlman. Pp. 47-58.
10. Equipping the Sewage Plant Laboratory. By N. C. Wittwer. Pp. 70-75.

H *Municipal Sanitation*
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9. Developments in Sewage and Waste Treatment During 1939. By W. Rudolfs. Pp. 57-63.
10. Pollution Control — Where Does It Stand? By A. Wolman. Pp. 64-66.
11. Refuse Incineration Continues Steady Growth. Pp. 67-71.
12. National Census of Sewage Treatment Projects. Pp. 72-81.
13. Sewering Darien, Conn. By C. L. Bogert. Pp. 82-84, 109.
14. Modern Sewerage Works for Muncie, Ind. By A. A. Burger. Pp. 85-87.

J *American City*
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5. New Primary Sewage Treatment Plant at Ypsilanti, Mich. Pp. 47-49.
6. Sewage Treatment Plant Built on Several Levels. Pp. 51-52.

P *PUBLIC WORKS*
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13. Garbage and Refuse Collection and Disposal Practices in Small Communities. Pp. 9-11.
14. Facts Regarding Community Sanitation. Pp. 17-18.
15. n. Pollution by Waste Sulphite Liquor in Green Bay, Wis. P. 18.
16. Trickling Filters—Their Design, Construction and Operation. Pp. 26-37.
17. p. Improved Sewage Clarification by Pre-Flocculation. By A. J. Fischer and A. Hillman. P. 54.

Damages From Sewage Disposal Plant

In an action against a city for damages caused by obnoxious gases and odors for a sewage disposal plant the Arizona Supreme Court said, on the question of liability (City of Phoenix v. Johnson, 75 P. 2d. 30), "No matter how great may be the necessity of providing a sewer system for the city, it may not rightfully be done in such a manner as to maintain a nuisance." In this case the equitable relief of injunction was not sought. Some authorities hold that even if the sewer does constitute a nuisance, the necessity of the municipality may be so great that injunctive relief by means of abatement will not be granted. But the court held the municipality's defense against actions at law was by the right of condemnation. It added: "No matter how closely a public sewage plant may follow the plans which theoretically are sufficient to prevent it becoming a nuisance, and no matter how efficiently such plant may be operated in accordance with those plans, if, as a matter of fact, nowithstanding this, it does create a nuisance, the fact of the proper construction and efficient operation does not constitute a defense to an action for damages."

Financing Sewer Construction

A city in Florida proposed to issue utility revenue certificates to secure a loan from the Federal Emergency Administration of Public Works to improve and extend its sewer system. The ordinance passed provided that the certificates would not constitute a lien upon any property or give any right for the appointment of a receiver or foreclosure against the proposed sewer system or any other property. The Florida Supreme Court held, Hess v. City of Orlando, 183 So. 473, that the city could pledge a portion of the income from electric and water plants realized by the city under existing rates, and that such pledging, under Florida Acts of 1935, Chap. 17118, was not an indetedness requiring an approval vote of the taxpayers.

Disputed Liability for Surface Water Drainage

In an action against a county for damages caused by the flooding of plaintiff's land by surface waters which accumulated thereon because of an inadequate culvert under the roadbed of a federal-state highway, the Wisconsin Supreme Court held, Leininger v. Pierce County, 277 N. W. 187, that the county under the state statutes, was not liable, because the highway, although located on land condemned by the county, which made appropriations for the improvement, was constructed and maintained by the State Highway Commission.

The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

Rapid Sand Filters Of Lawrence, Mass.

The first scientifically planned slow sand filters in the United States were built at Lawrence, Mass. in 1893. As the Merrimac river water became more polluted the filtration became less satisfactory, and in 1938 rapid sand filters were built. Some of the old filters were retained for secondary filtration when necessary; but these and the aeration plant had not been used when this paper was written.

The new filters are essentially conventional in design. The design capacity was 10 mgd. Equipment includes 2 Chain Belt mechanical intake screens. Three Allis-Chalmers vert. centrifugal raw water pumps of 5, 6 and 7 mgd respectively. Venturi meter, 30″ x 14″. Syntron dry feed for alum, lime and activated carbon. W & T manual control, solution-feed machines. Otis freight elevator for chemicals. Mixing tanks with New England Tank & Tower Co. paddles. Five coagulation basins with 3 Dorr flocculators, 11 ft. diameter, in each. Ten filters, 18 ft. by 20 ft. 4 in., with Builders Iron Fy. 10″ rate controllers; Norwood Engineering Co. operating tables, each controlling 5 hydraulic valves. Two 10 mgd Allis-Chalmers wash water pumps, with 24″ Builders Iron Fy. rate controller. For aeration, 70 Sacramento type nozzles, 100 gpm capacity. Low-service horizontal centrifugal pumps, 2 Fairbanks-Morse, 1 Lawrence Machine & Pump Co., 6 mgd each. High-service horizontal centrifugal booster pumps, Lawrence Mach. & Pump Co., one 2.6 mgd and one 2 mgd.; 2 W&T manual-control, vacuum solution feed chlorinators. Builders Iron Fy. venturi meters, 24″ x 10″ on low service, 16″ x 8″ on high service.

Inflow of raw water is controlled by a Dow pivot valve, the throttling action of which is controlled by a pilot valve actuated by the water levels both in the mixing tanks and on the filters, to prevent inflow surges.

The wash-water rate-controller is in the closed position when pumping starts, rather than in the normal wide open, to prevent initial excessive rates. A large illuminated dial on the end wall of the gallery shows rate of wash at any instant.

Low-service pumps are automatically primed by connection to a tank in which vacuum is maintained by a Nash motor-driven vacuum pump.

Purification effected has averaged reduction of 37° agar count from 920 per cc to 4; 20° agar count from 4700 to 10. In raw water, coliform organisms have been found by presumptive test in most 0.01 cc dilutions and occasionally in 0.001 cc dilutions; of filtered water, 13 out of 600 10 cc inoculations gave positive presumptive tests for coliform bacteria.[B2]

Transporting 18-Ft. Cast Iron Pipe

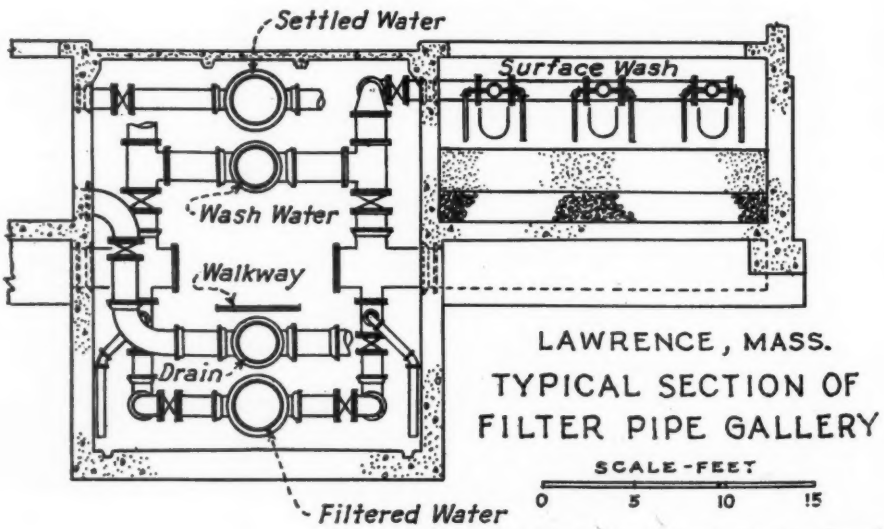
For this purpose the following equipis recommended; a heavy-duty 2-ton truck chassis with a wheel base of at least 220″. Three feet back of the cab is occupied by a crane of 3,000 lb. capacity with a 10 ft. boom, mast demountable. Platform body 17 ft. long, projecting one foot beyond end of frame. This will safely carry 4 tons of pipe.[G5]

Coliform Bacteria In Chlorinated Water

Studies of the persistence of coliform bacteria in chlorinated water supplies led to the following conclusions: Coliform bacteria not subjected to positive 2 P-M conditions will resist chlorination for hours at near-freezing temperatures. (2 P-M value is twice the phenolphthalein alkalinity minus the methyl orange alkalinity.) Therefore short-circuiting or rapid skimming of clarified water in basins may introduce into the filters coliform organisms which will resist chlorination for as much as 24 hrs. at low temperatures. The 2 P-M value must be adjusted and correlated with the temperature relations and retention after chlorination to effect a reduction of resistance sufficient to assure coliform-free water. During low temperature seasons, a chlorine residual approximating 0.5 ppm in cold water may be desirable, using the orthotolidine test. When the turbidity of the raw water is low, it may nevertheless be necessary to add sufficient lime to obtain attenuation of coliform bacteria and incidentally take advantage of softening reactions. If use of lime is not desirable, then there must be sufficient storage capacity to effect chlorination at the prevailing temperature and pH values.[G8]

Ozone Treatment At Delhi, N. Y.

Water for this village of 1800 was treated with ozone from 1928 to 1935, when it was discontinued because of excessive cost of operation and replacements. Disadvantages are (1) cost of equipment; (2) difficulty of average operator to understand and supervise it; (3) low solubility of ozone; (4) lack of a satisfactory test for residual ozone that will permit accurate control of dosage.[B3]



Courtesy New England Water Works Assn. Journal

Typical section, filter pipe gallery.

Chlorinating New Mains in Providence

Previous to 1936, Providence, R. I., only flushed new mains before placing in service. Then, using a "Chlor-O-Feeder," it filled the new mains with water dosed with 50 ppm chlorine which was left in for 48 hrs. After flushing out until no residual showed, bacterial tests were still unsatisfactory. This was found to be due to the hemp in the joints, which is not readily chlorinated. Now the hemp, before being placed in the joint, is soaked in a solution containing 100 ppm of hypochlorite; and the chlorinated water is kept in the mains 7 days.[F24]

Heavy Chlorination Disinfects Highly Polluted Water

At South Fallsburg, N. Y., pressure filters did not effectively remove solids and taste-producing compounds because of faulty operation and excessive rates; but heavy prechlorination followed by dechlorination through carbon units effectively disinfected, with short reaction periods and without producing chlorinous tastes, polluted water containing large concentrations of organic matter. Effectiveness of chlorination does not depend upon varying the chlorine dosage to meet moderate changes in chlorine demand of the raw water, but on the use of concentrations sufficiently heavy to meet maximum requirements, giving reliable results without close technical supervision. Granular carbon beds will remove residual chlorine from water long after they have lost their power to adsorb taste and odor-producing compounds, due to the fact that chlorine is not removed by adsorption but directly reacts with the carbon.[B3]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

A *Journal, American Water Works Ass'n.*
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31. Water Softening and Filtration Plant, Metropolitan Water District of Southern California. By J. M. Montgomery and W. W. Aultman. Pp. 1-24.
32. Silting of Reservoirs. By L. S. Hall. Pp. 25-42.
33. c. Mono Craters Tunnel Construction Problems. By H. L. Jacques. Pp. 43-56.
34. Water Districts Pro and Con. By A. Russell. Pp. 57-61.
35. New Law on Water and Sewerage Districts. By W. B. Cheek. Pp. 62-64.
36. Specifications for Construction of Deep Wells. By J. C. Harding. Pp. 65-71.
37. Standard Specifications for Deep Well Pumps. By J. A. Carr. Pp. 72-76.
38. Main Cleaning. By W. S. Staub. Pp. 77-84.
39. Observations on Water Softening. By D. E. Davis. Pp. 85-92.
40. Development of Submerged Combustion for Recarbonation. By L. H. Scott. Pp. 93-97.
41. t. Procedures for Detection of Coliform Organisms in Minnesota Drinking Water. By D. M. Taylor. Pp. 98-104.
42. Swimming Pool Water Treatment. By H. L. White. Pp. 105-114.
43. Grounding of Electric Circuits on Water Pipes. By J. B. Downes. Pp. 115-120.
44. Filter Sand. By T. M. Riddick. Pp. 121-146.
45. Effectiveness of Sand Filters in Removing Floc. By G. B. McCall, S. E. Edwards and E. S. Hopkins. Pp. 147-151.
46. Filter Sand—From a Producer's Standpoint. By H. J. Gerrard. Pp. 152-154.

B *Journal, New England Water Works Ass'n.*
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1. British Water Works Practice. By J. Bowman. Pp. 385-411.
2. Construction and Operation of Rapid Sand Filters at Lawrence, Mass. By A. L. Shaw and E. S. Chase. Pp. 412-443.
3. Significant Experience in the Treatment of Water in New York State. By C. R. Cox. Pp. 444-475.
4. Combating Backflow in Water Supply Systems. By R. H. Zinkil. Pp. 458-472.
5. Outbreaks of Water-Borne Diseases in the New England States, 1920 to 1936. By A. E. Gorman. Pp. 473-504.

E *Engineering News-Record*
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7. Sanitary Engineering: Review of 1939. By E. J. Cleary. Pp. 64-65.

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8. Plugs for Aqueduct Testing Formed from Steel Plates. By Stanley M. Dore. Pp. 60-61.
9. Computing Hydraulic Elements of Irregular Cross-Sections. By Z. P. Kirpick. P. 65.

F *Water Works Engineering*
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22. Metering at Manchester, N. H., Decreases. Unaccounted-for Water. By P. A. Shaw. Pp. 166-168.
23. When Public Officials Ahe Exempt from Income Tax. By L. T. Parker. Pp. 169-171.
24. Chlorinating New Mains. By P. J. Holton, Jr. Pp. 172-173.

25. Tunnel Muck Disinfected (Delaware River water system). Pp. 174-175.
26. p. Water-Borne Outbreaks in New England for 1920-1936. By A. E. Gorman. Pp. 196-199.

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27. Water Supply of Kansas City. By T. D. Samuel, Jr. Pp. 222-225.
28. Maintenance and Repair Trucks Show New Features. Pp. 226-229.
29. Service Installations. Pp. 232-234.

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5. c. Transportation of Cast Iron Pipe. By D. R. Taylor. P. 59.
6. p. Experiences With the New Rubber Joint Packing. By W. R. La Due. Pp. 60-61.
7. America's Most Unique City Hall. By M. Call. Pp. 62-64.
8. The Presence of Coliform Bacteria in Chlorinated Water. By G. W. Freiberg. Pp. 65-69.
9. A Simple Turbidimeter for Fairly Clear Water. By A. A. Hirsch. Pp. 76-77.
10. Boston's New Conduit. P. 78.

J *American City*

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7. Historic Filtration Plant at Lawrence, Mass. By T. A. Kendall. Pp. 39-41, 52.
8. Treating Lake Michigan Water at Muskegon Filtration Plant. Pp. 56-57.

P *PUBLIC WORKS*

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8. Water Improvements at Ilion, N. Y., Include Softening. By E. J. Trimble. Pp. 15-16.
9. n. Solving the Frozen Riser Problem in Elevated Tanks. P. 16.
10. n. Electrical Trawing of Water Pipe. P. 16.
11. How the Bradford, Pa., Water Department Keeps Its Records and Files. Pp. 20-21.
12. n. Lining Pasadena's New Reservoir. P. 24.
13. n. Tank Details for a Warm Climate. P. 24.

Water Company Not Liable for Meter Box Accident

In an action against a city and a water company for injuries sustained in stepping into a hole surrounding a water meter box on a parkway maintained by the city, the Kansas City Court of Appeals, Bantz v. City of Sedalia et al., 120 S. W. 2d. 59, held that the water company was not liable in view of an ordinance providing that the water company should own and keep in repair the water meter box and that the consumer should put it in, maintain and repair it under the water company's supervision.

"Self-Liquidating" Water Supply System

The New Jersey Board of Public Utility Commissioners says that the standard set up in the statute authorizing the Board to determine that the income from a proposed municipal supply and distribution system is sufficient to make the utility self-liquidating, i. e., "on the basis of a project report prepared by the engineer," is only for the guidance of the Board. The legislature, it holds, did not intend that the Board should accept without question the engineer's report. Where there was no evidence, (Re Borough of Lincoln Park) to enable the Board to determine that the municipality will be financially able to carry out the provisions of the State Water Policy Commissioner's order of approval without resorting to the right of eminent domain, the Board declined to find the project to be self-liquidating within the meaning of the statute. The project in question was the acquisition of a new source of water supply for a municipal water system.

Disposal of Retained Percentage

The highway act of Nevada, as amended in 1925, provides that retained percentages held by the highway department on the completion of a highway contract shall be payable to the contractor without regard to creditors' claims filed with the department. The Nevada Supreme Court holds (Union Indemnity Co. v. A. D. Drumm, Jr., Inc., 62 P. (2d) 698) that where the contract is completed, the retent must be paid to the contractor. The act provides that one-third of the contractor's bond shall be conditioned as "additional protection" for those furnishing labor and supplies. The Legislature is presumed to have contemplated that this one-third was ample protection. Although the court regarded the amendment as an unfortunate one, it held that under the highway law as it exists no equitable lien exists in favor of job creditors.

Letters to The Editor:

(For "Timewasters" see page 9 of this issue.)

Dear TIMEWASTERS:

SOME FISH!

Head	9″,	as stated;
Body	36″;	
Tail	27″;	Total, 72″.

'Tain't fair to give football problems. All I know about the game is that when I was a boy, twenty-two fellows took funny-looking positions on a field while one added—aloud—a column of figures, and if he got the wrong answer all of the gang fell down in the mud.

Dear TIMEWASTERS:

Did the Ball Carrier Make a Touchdown? I'll say he did. After he had travelled a hair over forty yards the tackler had travelled a hair over forty-eight yards and was still a good yard-and-a-half back when the touchdown was made or I don't know my football. And—Tom's fish was six feet long.

Seems that there are a number of answers to the bandit problem. Assuming that the brothers take the most and leave what's left to their hermana:

273	
198	
183	
654	One brother
	21—two dollar bills
258	
228	
168	
654	Other brother
	19—two dollar bills
213	Sister

It will be very interesting to know how many correct answers are handed in.

The mules carrying 273 lbs. and 258 lbs. are O. K., but where did you pick up the three puny beasts carrying less than 200 lbs. each?

Just before the turn of the century I had a mule belonging to the United States Government Survey that packed 300 lbs. over mountain trails. But poor old Billy got drowned while fording the Sauk River in the Washington Forest Reserve. He fell down, and the 300 pounds on his back kept him down. Poor Billy!—W. S. W.

My answers to the Timewasters have been wrong so much recently that I'm getting a superiority complex. I've been told that all good mathematicians were a bit crazy. Maybe I am sane, in spite of what my friends all say.

But speaking of fish—Oh, Heck! There comes another customer. You'll have to excuse me. I can't tell a good story when bothered by business. Timewastefully yours—C N E.

Dear TIMEWASTERS:

That "Football Coach Special" timewaster in the January issue is a very neat little problem although it looks innocent until tackled. The results of my solution show that he failed to make the touchdown by 6 2/3 yards. I gave the problem to some of the students taking the calculus actuarial examination and they tried to integrate some differential equations, needless to say without success. However I haven't been able to prove that my solution is a singular solution as I assumed a set of parametric equations and solved for the unknown coefficients. Is there any way of proving that there is only one solution or is there always the possibility of an exponential or logarithmic function? J L B.

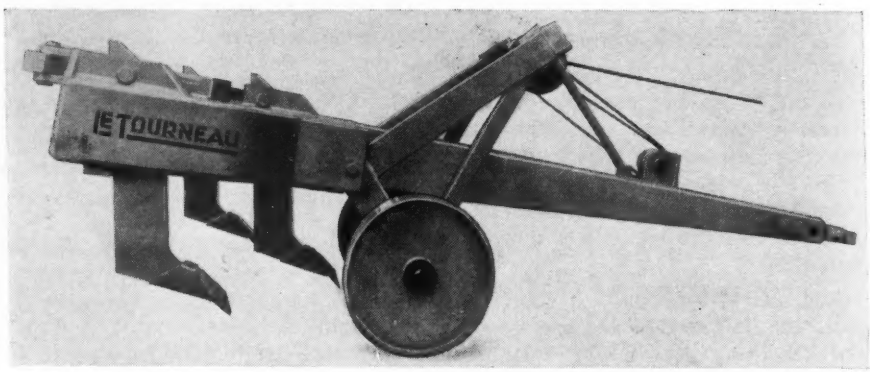
Keeping Up With New Equipment

"Toothed Dynamite"

To speed scraper production, eliminate blasting, and extend scraper efficiency into rock, shale, and hardpan, R. G. LeTourneau, Inc. of Peoria, Illinois, has produced the largest, heaviest, and strongest rooter ever built, the 9150 pound Extra Heavy Duty K3. This comes equipped with three teeth which have a maximum depth of 28". Each is removable to meet job conditions for ideal fragmentation. The center of the three teeth is set ahead of the others to gain quicker penetration in the hardest material.

In order to give easier penetration and keep the rooter teeth feeding into the material, the ends of the rooter shanks are built at a steeper angle than formerly employed on rippers. A bumper frame, mounted on the rear, gives the added advantage of the use of a pusher tractor in the toughest material and greatly increases the weight of the rooter for effective digging.

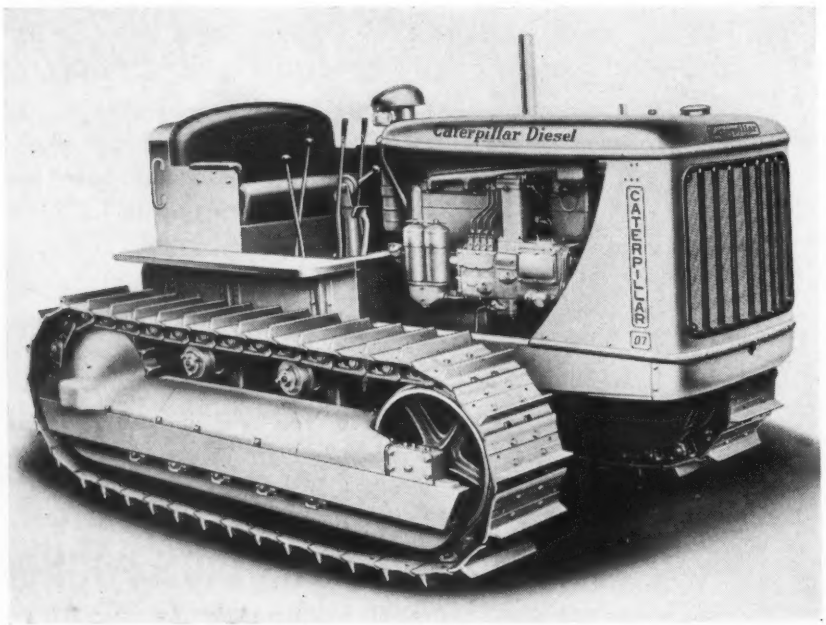
Further information on the K3 Rooter may be secured from LeTourneau and Caterpillar Dealers or by writing R. G. LeTourneau, Inc., Peoria, Ill.



New Le Tourneau Extra Heavy Rooter

Caterpillar New 75-HP Diesel Tractor

Caterpillar Tractor Co. has announced a new 75 drawbar horsepower tractor, the Diesel D-7. Weight is 23,500 pounds; engine is 4-cylinder; 1000 rpm.; belt horsepower 87; speeds, 5 forward, 1.4 to 5 mph., plus a high-speed transmission to give 6 mph., and 4 reverse. Finger-tip control has been provided. This new tractor was first shown at the 1940 Road Show. Full details from the manufacturer.

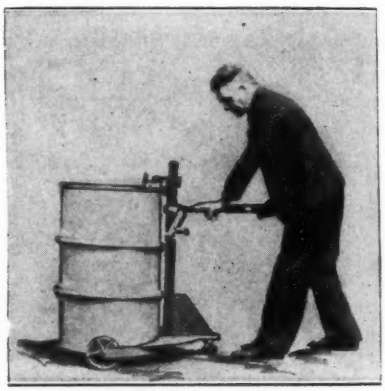


New 75-h.p. Caterpillar Diesel.

Barrel and Drum Handler

A new handling device for barrels and steel drums, markedly increasing the safety of this operation has been placed on the market by Chas. K. Ernst, Inc., 999 E. Ferry St., Buffalo, N. Y. The Ernst "Magic" drum and barrel carriers will prevent lost time accidents and annoying, expensive compensation cases caused from injuries and ruptures to workmen having heavy drums and barrels to move, the manufacturers declare. No breaking over of load, no tipping, slipping or dumping is required. These carriers protect the truckmen from injury and prevent damage to floors, containers and their contents.

With one hand a 500-pound load or larger can be lifted straight up and locked, allowing easy movement with two fingers. The load is always self-balanced. According to the manufacturer, the truck does all the work, the operator merely guides it.



The Ernst Drum Handler

New Development in Service Boxes

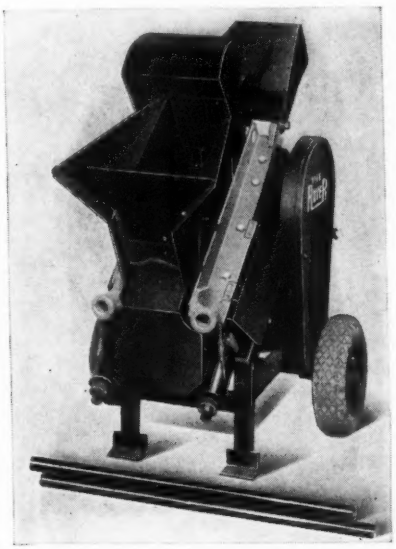
A new catalog by the Central Foundry Co., 386 Fourth Ave., N. Y., features and describes the new Monitor Service box, a new development in this line, and also presents a complete line of Roadway, Valve, Gas Drip and Test Valve boxes. 16 pages; sent on request.

Allis-Chalmers Diesel Tractor

A new 32-page, 2-color catalog describes the new Allis-Chalmers HD14 diesel tractor, which weighs 27,800 pounds, has a 130-hp (belt—drawbar is 108-hp) motor, and speed up to 7 miles an hour. The engine is the General Motors 2-cycle diesel. The catalog tains a full description.

The Redesigned Royer Sludge Distintegrator

The Royer Foundry & Machine Company, Kingston, Pa., have redesigned their sewage sludge disintegrator for shredding, mixing, aerating and further reducing the moisture content of sewage sludge cake from the drying beds to prepare it for fertilizer, according to an announcement just released by them.



Improved Royer Sludge Disintegrator

Capacities in every case remain unchanged and these changes have made possible lowered prices on these models.

Redesigning has effected reductions in weight up to 20% and lowered shoveling heights up to 7". These changes affect all electric powered models of the Royer Sludge Disintegrators. The gasoline engine driven and belt-to-tractor driven models remain unchanged.

Chemical Mixers and Feeders

A new bulletin describes Infilco chemical mixers and feeders for the uniform preparation and feeding of suspensions or solutions in water, sewage and process liquid conditioning and in other applications. Copies of this bulletin, No. 350-A, are available upon request from International Filter Co., 325 W. 25th Place, Chicago, Ill. These mixers and feeders employ a type of agitation, which assures uniformity in the solution or mixture. They offer the very accurate means available for feeding a suspension or solution. Two chemicals may be prepared and fed together, and the discharge can be divided into two variable portions for use at two different points.

Course in Estimating

A new course, "Construction Estimates and Costs," of wider scope than a previous course of similar name, is offered by the Extension Division of the University of Wisconsin, Madison. The course places emphasis upon correct methods of estimating the quantities and costs of materials, labor, and equipment required in construction work, the costs of overhead, and allowances for profit. Both tables and diagrams are used. Many illustrative estimates are included. The Department of Civil and Structural Engineering, upon request, will send detailed information on the course.

Activated Alum Handles Palmer Filter Sweep

Activated Alum Corp., Curtis Bay, Baltimore, Md., in addition to handling also, as distributors, Cape May filter sand and HTH, represent the Palmer Filter Sweep. One unit has been installed at Newport News and three more are ordered, and Buffalo is considering installation. Full information on this from Fred Stuart at the above address.

Maryland-Delaware Water & Sewerage Ass'n.

The fourteenth annual meeting of this association will be held in the Wicomico Hotel, Salisbury, Md., May 16 and 17. A. W. Blohm, 2411 N. Charles St., Baltimore, Md., is secretary and will supply programs and other information.

New England Sewage Works Association

The spring meeting of this association will be held on April 16 at Higgins' Inn, Middletown, Conn. The program includes an inspection of the new sewage treatment plant and incinerator at Middletown and a number of papers, among which are: Operation and maintenance of sludge gas burning systems, by L. L. Langford; Design of the sewerage systems in Cranford, R. I., by Ralph W. Horne; Sewage research, by Prof. Charles R. Hoover. LeRoy W. VanKleeck, State Department of Health, Hartford, Conn., is secretary.

New Jersey Sewage Works Ass'n.

Plans for the 25th anniversary meeting of the New Jersey Sewage Works Ass'n. are now completed. Convention headquarters will be at the Hotel Stacy-Trent and exhibits will be located in the War Memorial Building nearby. The meeting will be held March 21-23.

Claude C. Hill, associated for many years with Kinney Mfg. Co., Boston, died Feb. 16, following an operation.

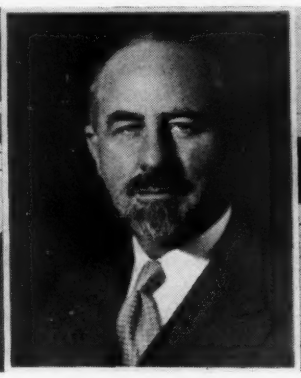
Dorr and Wallace Receive Plaques; Baker Also Honored

Awards were made, on the 150th anniversary of the founding of the U.S. Patent system, by the National Association of Manufacturers, to a group of American inventors and research scientists. John Van Nostrand Dorr, president of the Dorr Co. and Charles F. Wallace, vice president of Wallace & Tiernan Co. were among the nineteen to receive awards as "modern pioneers." Dr. John C. Baker, director of research, Wallace & Tiernan Co., received a scroll as one of the one hundred inventors selected from the metropolitan area.

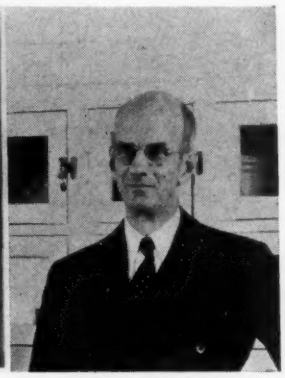
Mr. Dorr received the National Award as one of the leading chemical, metallurgical and industrial engineers of this country, as well as a prolific inventor of machines and processes that have had far-reaching effects on American industrial and social progress. His own many inventions, supplemented by those of his engineering staff (a total of over 1400 patents), have been applied successfully in 70 separate and distinct processing industries, making feasible the conversion of intermittent processes to continuous ones; the large-scale exploitation of low-grade ore deposits; and, finally, the placing of municipal sewage and water treatment on a sound engineering basis, to the benefit of the public health of this and other countries.

The award to Mr. Wallace was in recognition of his work in the development of chlorine control apparatus and that to Dr. Baker for his research work in the field of cereal chemistry. Today more than 85% of the country's domestic drinking water is sterilized by chlorination made possible largely by the genius of Charles F. Wallace; while in the flour milling industry the inventions and discoveries of Dr. Baker in aging and maturing of flour, particularly the Agene Process, have received similar world wide acceptance.

Charles F. Wallace



John V. N. Dorr



John C. Baker

Barrett Tarvia
GOOD ROADS AT LOW COST

The special tire-gripping surface of this Barrett-engineered road surfacing reduces danger of skidding to the minimum — even in slippery weather.

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